# SCIENTIFIC & ECOLOGICAL EXPEDITION NANDADEVI

2nd May to 22nd July 1993

Box No. 157

**Corps. of Engineers (Army)**
**Wildlife Institute of India**
**Salim Ali Centre for Ornithology & Natural History**
**World Wide Fund for Nature - India**
**G.B. Pant Institute of Himalayan Environment & Development**
**Botanical Survey of India**

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# FOREWORD

The Corps of Engineers have been pioneers in the field of many sports and adventure activities. On the ocassion of the Golden Jubilee celebrations of its Alma-Mater,the "College of Military Engineering (CME), Pune", the Corps has ventured into the field of Ecology, environment and mountain cleaning.

The last two decades the world over, have seen an explosion of knowledge in the area of Environmental Science. Man's concern over the depleting ozone layer, global warming, degradation of forests, dramatic climatic changes has suddenly touched a new high and is even bordering on hysteria in the developed West. Scientists have begun to warn man that apocalypse is not far away and have been painting frightening scenarios on how the time is not far off, when man will be called upon to pay for the sins of the past.

Joining hands with a number of developed countries, India is taking the lead in driving home some basic truths about life on our planet and has been actively participating in several international fora and expeditions. The Corps of Engineers Scientific and Ecological expedition -1993 was also a step in this direction. Its objective was to arouse Environmental awareness and also clean up the mountain basin in the Nanda Devi National Park. This unique expedition was under taken with the following aims:-

1. To prepare a comprehensive listing of the flora and fauna.
2. To assess the habitat and floristic diversity.
3. To assess the status of flora and fauna particularly of the endangered species.
4. Natural resource utilisation pattern of the villages within the buffer zone of the Nanda Devi Biosphere Reserve.
5. To assess the status of forests in the buffer zone with particular reference to areas used by the villagers.
6. To gather base line information on water quality of the Rishi Ganga river system.
7. To clean up the National Park and approach route, of the garbage left by previous expeditions.
8. To scale Nanda Devi and clean higher camps.

The expedition comprised of a climbing cum support team from the Corps of Engineers and six scientists.

(a) Capt. Ashwin Baindur - Entomologist, Corps of Engineers.
(b) Dr. B.Balodi - Botanist, Botanical Survey of India, Dehra Dun.
(c) Dr.S.S.Samant - Botanist, G.B.Pant Institute of Himalayan Environment & Development, Kosi-Katarmal, Almora.
(d) Dr. Ravi Sankaran - Ornithologist, Salim Ali Centre for Ornithology & Natural History, Coimbatore.
(e) Mr. S. Sathyakumar - Mammologist, Wildlife Institute of India, Dehra Dun.
(f) Mr. Ajay Rastogi - Environmentalist, World Wide Fund for Nature- India, New Delhi.

The scientists were provided complete administrative and logistic backup by the Corps of Engineers (Army). The duration of the expedition was from 02 May 1993 to 22 June 1993, atotal of 52 days in the sanctuary. The team was accompanied by Mr. V.K.Pangtey, DFO, Nanda Devi National Park and four of his staff members. All the scientists carried out their study, as per their specific requirements and nature of work. The detailed reports are enclosed in this combined report.

The combined conservation measures as suggested by the study team are:-

1. The core area of the Nanda Devi Biosphere Reserve should remain inviolate.
2. A periodic assessment survey to be made once every five or ten years.
3. On no account should permits be issued for scaling of peaks within the core zone.
4. As the buffer zone is a multiple use area with villages within it, we recommend:
    - (a) Development of Environment friendly tourism in the buffer zone to enhance the economic resources of the local populace.
    - (b) Stricter vigilance in wildlife rich areas of the buffer zone.
    - (c) Encouragement be given to villagers/ Forest Department to cultivate plants that are rare endangered, of medicinal or other values.
    - (d) Medicinal produce or wild cultivators from this area should not be exported in raw form, but adequate infra structure including marketing linkages be created to process products, thus adding value to the produce and its benefits reaching the locals.
5. Better infra structure (equipment, clothing, incentives & food) be provided to the wildlife guards of the Forest Department to help them patrol the inhospitable and inaccessible areas of the Nanda Devi Biosphere Reserve.
6. Institutional tie-ups be made with the Army, to enforce stricter vigilance for protection of the Nanda Devi Biosphere Reserve and such areas in the country.
7. A policy be evolved and this be strictly enforced that all expeditions either mountaineering trekking or scientific bring back all garbage created by their expeditions to the road head.
8. Necessary encourage ment and all help be given to future expedition whose prime objective is to clean up our mountains.

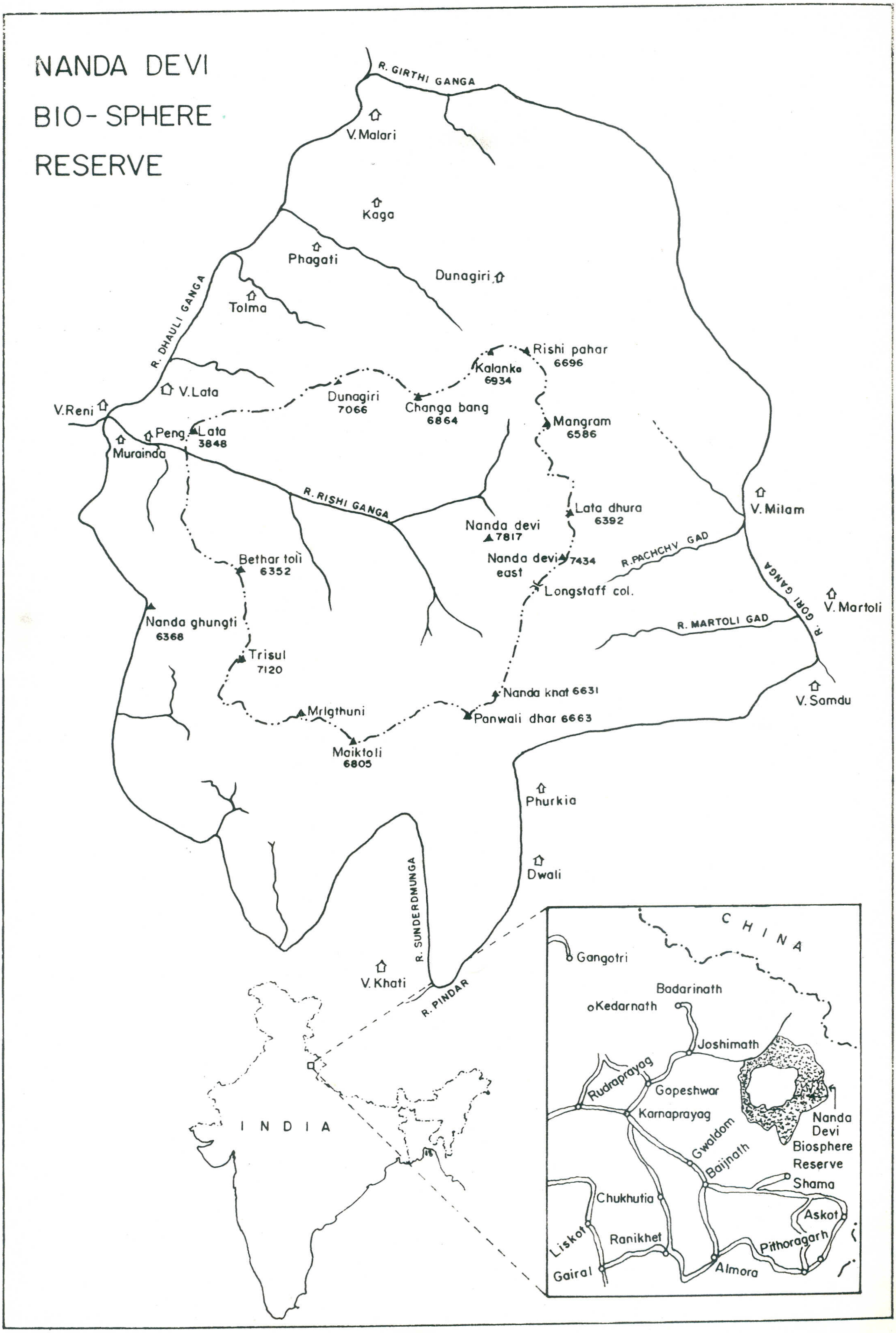
All the scientists and the support team members were extremely happy with the conduct and execution of this joint venture. It is recommended that more of such joint ventures be planned in the future.

Our Earth, once regarded as the universal provider today finds it difficult to provide even our basic requirements of survival. These ecological difficulties are born out of ignorance and apathy of the people and end up with people as victims. The Corps of Engineers' Scientific and Ecological expedition to Nanda Devi was a new and fruitful approach towards the conservation of our unique and valuable ecological heritage. I am sure, in future many such ventures will be undertaken by the Govt., the NGOs, other institutions and mountaineering/trekking clubs in the country.

New Delhi
19 July 1993

**Lt. Col. V. K. Bhatt**
Leader of the expedition

# NANDA DEVI BIO-SPHERE RESERVE



# NANDA DEVI BIOSPHERE RESERVE
# AN OVERVIEW

## HIMALAYAS

The Himalayayas are perhaps the richest biogeographic zones in India. It is the largest mountain system in Asia and its main chain extends as an arc from Chitral in the west to Patkai hills in Arunachal Pradesh to the east. In all, the Himalayas cover 422200 sq. km. (nearly 13% of India's land surface). The location, climate and topography has enriched the Himalayas with rich and diverse lifeforms. Based on the vegetational features and faunal assemblages, the Himalayas has been classified as North Western, Western, Central, Trans and Eastern Himalayas. Of these, the Trans Himalaya (mainly the cold deserts of the Tibetan Plateau) occupy the largest area (186200 sq. km. or 44%) while the rest range from 12000 sq km (or 3% - central Himalaya) to 83000 sq. km. (19% - eastern Himalaya).

Within this vast and diverse biogeographic zone exists a Protected Area Network that has made a beginnining at conserving representative flora and fauna. The Himalayas as a whole have 58 protected areas, covering an area of 12539 sq. km. (less than 3%). Western Himalayas itself has 17 protected areas covering 3885 sq. km. (5%) of its area. Nanda Devi National Park and Biosphere Reserve is an important Protected Area of this biogeographic zone.

## HISTORY OF CONSERVATION

The history of conservation of the Nanda Devi region dates back to 1939 when the entire Rishiganga basin was declared a Sanctuary. In 1982, the area was declared a National Park., primarily because excessive trekking and mountaineering pressures had seriously damaged this fragile Himalayan ecosystem. The last expedition to Nanda Devi was in 1981. On 18th January 1988, the Nanda Devi Biosphere Reserve (NDBR) was established under the Man and Biosphere programme of the UNESCO.

## LOCATION AND BOUNDARIES

The Nanda Devi Biosphere Reserve is situated in the Kumaon and Garhwal region of western Himalayas. It is located in the civil districts of Chamoli, Pithoragarh and Almora between 79 40' E & 80 5' E and 30 17' N & 30 41' N and covers an area of 2236.74 sq km. Prominent natural features comprising the boundaries of the NDBR are :

| | | |
|---|---|---|
| North | : | Village Mallari and tributary of river Girthiganga |
| North-West | : | Along tributary of Girthiganga upto Untadhara and from then on along the tributary of river Goriganga upto Milam. |
| South-East | : | From Milam to Martoli along the river Goriganga and fromMartoli to Khati along the river Pinder through Phurkia and Dwali. |
| South | : | From Khati along Sunderdhunga Gad to Sunderdhunga to Samder. |

South-West : Samder - Dhak - Mulkhet - Baratoli - Tribhuj - Nanda Ghungti.
North-West : Nanda Ghungti - Rounti - Reni - and then along river Dauliganga upto Malari.

## AREA AND ZONATION

The NDBR consists of an inner core zone and an outer buffer zone totalling to 2236.74 sq. km. The area of Nanda Devi National Park (NDNP) excluding a small projection leading towards Dhauliganga forms the core zone of the NDBR. The projection has been excluded because of the presence of the village Peng within it. The core zone of the NDBR covers an area of 624.62 sq km. The boundary of the core zone is well defined. It consists of very high ridges with peaks such as Lata, Jhandidhar, Dunagiri, Changbang, Kalanka, Rishiparvat, Nanda Devi East, Nanda Khat, Mrigthuni, Trisul and Nanda Ghungti. The Nanda Devi peak is within the core zone (NDNP) of the NDBR and at 7816m above msl is the second highest peak of India.

The buffer zone of NDBR encircles the core area and covers an area of 1612.12 sq km. The buffer zone is an area of mutliple uses. While conservation of natural resources is of of major importance, local villagers are permitted to use the resources to meet daily needs and tourism (trekking etc.) is also permitted.

## VILLAGES

15 inhabited villages are present within the buffer zone (Fig. 1, Table 1), the people belonging to two main ethnic groups namely Indo-Mongoloid (Bhotia) and Indo-Aryan. The Bhotia still exhibit seasonal altitudanal migration and most of their winter villages are present outside the NDBR.

Table - 1

| District | Village | Human population | Cattle population |
|---|---|---|---|
| Chamoli | Reni | 201 | 860 |
| | Lata | 325 | 289 |
| | Peng | 123 | 780 |
| | Tolma | 91 | 368 |
| | Suraithota / Sigri | 85 | 241 |
| | Phagti / Pangrasu | 65 | 1393 |
| | Jamgavar / Dunagiri | 258 | 270 |
| | Kaga | 104 | 463 |
| | Garpag | 47 | 174 |
| | Malari | 759 | 1492 |
| Pithoragarh | Kurkuli | - | - |
| | Milam | 99 | 475 |
| | Martoli | 31 | 365 |
| Almora | Khati | 197 | 234 |

# STATUS OF MAMMALS IN NANDA DEVI NATIONAL PARK

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## INTRODUCTION

The fragile Himalayan mountain ecosystems are well known for their wide varied biological, ecological and hydrological resources and aesthetical values. Man has been an integral part of this ecosystem and has been exerting considerable influence on animals and their habitats. Yet, there is virtual lack of information on the extent and magnitude of man's impact on this ecosystem. While most of the areas in the Himalayas have been under the influence of man, a few inhospital remote areas have remained inaccessible for man and his activities. The Nanda Devi basin is one such area which had remained naturally protected due to inaccessibility until 1938 but was threatened later due to large scale mountaineering and trekking. The increasing impact due to human activity to this wilderness area resulted in closing this area for all human activity in the year 1982 by declaring it as a National Park (Khacher, 1983). Since then, this Protected Area (PA) had remained free of human interference.

## OBJECTIVES

- ( i ) To collect information on the distribution and relative abundance of ungulates.
- (ii) To assess the changes in status of mammals by comparing their status with results of earlier surveys.

## METHODS

An ecological survey using rapid assessment techniques was conducted from 2*nd* May, 1993 to 22*nd* June, 1993. Estimating density of an animal in the Himalaya is often handicapped due to several reasons (Sathyakumar *et al.* 1990; Rodgers, 1991). The technique that is best suited for rapid assessment surveys in the Himalayas is estimating the "Encounter Rate". This includes both animal sightings as well as their evidences. Encounter Rates were calculated by using the formula: ER = n/l; where *n* is the number of sightings or evidences encountered and *l* is the distance surveyed (Sathyakumar *et al.* in press a). Evidences of animals include droppings (old or fresh pellet groups & scats) and tracks. Apart from the survey routes, some areas were surveyed more intensively by camping in localities such as Dibrugeta, Deodi, Ramni, Bethartholi, Sarsopatal and north PA. In Sarsopatal, an attempt to estimate the number of blue sheep was made by total counts for ten days. For every mammal sighting, data on species, number and age & sex (if possible) were recorded. Common leopard and snow leopard scats (droppings) were collected for analysis of food items later.

# RESULTS

During the survey, seven mammalian species were sighted and the existence of three more species in this PA was confirmed based on evidences. The Himalayan Musk deer *Moschus chrysogaster*, Himalayan tahr *Hemitragus jemlahicus*, Blue sheep *Psuedois nayaur*, Himalayan Weasel *Mustela sibirica*, Himalayan yellow throated Marten *Martes flavigula,* Red Fox *Vulpes vulpes* and Pika or the Himalayan Mouse Hare *Ochotona royeli* were sighted. The Snow leopard *Panthera uncia*, common leopard *Panthera pardus* and Serow *Capricornis sumatrensis* were confirmed by evidences. Earlier studies (Tak & Kumar, 1987; Lamba, 1987) and secondary information from local villagers confirmed existence of the Himalayan black bear *Selenarctos thibetanus.* One probable sighting of the red giant flying squirrel *Petaurista petaurista* was had inside the PA (Ravi Sankaran *pers comm.*) but needs to be confirmed. The Himalayan brown bear *Ursus arctos* is reported to occur here (Lamba, 1987) though local villagers have not seen it. The existence of the brown bear is yet to be confirmed. In total, eleven species occur in this PA and four more occur just outside this PA, but inside the Nanda Devi Biosphere Reserve. Of these, the Goral *Naemorhaedus goral*, Common langur *Presbytes entellus*, Rhesus macaque *Macaca mullata* and Jackal *Canis aures* were sighted. The results of the survey are presented species wise below:

## Himalayan musk deer

The endangered Himalayan Musk deer was sighted on 28 occassions (32 individuals) in the PA (Fig.1, Table 1). Most of the sightings were in Dibrugeta (3,500 - 3,800m)(16 individuals in 14 sightings). In Bethartoli (3,800 - 4,000m) and Deodi (3,300 - 3,500m) areas, 10 individuals were encountered in five and four sightings respectively. The Encounter rates for musk deer based on sightings along survey routes were between 0.0 and 0.2/Km walk (Table 2). The pellet group encounter rates ranged between 0.0 and 4.9/Km walk along the survey routes. The Dudh Ganga - Dibrugeta and the Deodi - Ramni routes had relatively higher pellet group encounter rates of 4.9 and 4.2/Km walk respectively (Table 2).

The silent drive count technique is best suited for estimating musk deer numbers for an area (Green, 1985; Sathyakumar, *in prep.*). In Nanda Devi National Park, using silent drive count was found to be very difficult due to very steep rugged terrain. Hence, in Dibrugeta meadow area, five small survey lines were sampled for musk deer sightings and pellet group encounter rates. The encounter rates ranged from 0 to 2 individuals/Km walk and 7 to 9 pellet groups/Km walk. The Dibrugeta meadow flanked by forested ridges was used by atleast 2 to 3 individuals. In Bethartoli, five individuals were sighted in four sightings in *ca.* 0.5 Km walk. The subalpine forests interspersed with meadows of Dibrugeta and Bethartoli provides ideal habitat conditions for musk deer.

Six musk deer kills were encountered in the PA, of which three were in Deodi -Bethartoli areas, one each at Dibrugeta, Dharansi and between Malla Chinwari and Dudh Ganga. These kills may be either due to poaching or predation. The remains of kills at Dibrugeta and Malla Chinwari had bones, skin, tooth and hooves indicating predation. The other kills were just skin and hairs scattered in a $2\ m^2$ area and without any other evidences of predation such as drag marks, bones etc. Such kills were near caves or camping sites where evidences of camping were also found. These kills were of musk deer poached.

Qualitatively, based on the Habitat Suitability Index (HSI) Model for the Himalayan Musk deer (Rawat, *in press*), the habitats in Dibrugeta, Deodi, Malla Deodi (3,900m) and Bethartoli have recuperated well as indicated by the extent of shrub cover.

### Blue sheep

The bharal or blue sheep was the most commonly encountered ungulate in this PA. In total, 990 individuals were sighted in 63 group sightings. Sarsopatal (4,100 - 4,300m) and north PA (3,800 -4,500m) accounted for 633 in 38 and 234 in 13 group sightings respectively (Table 1). Blue sheep were sighted at Dibrugeta, Bhojgara (4,000m), Patalkhan (4,200m), Bagni (3,800 - 3,900m) and Bethartoli areas (Fig.1). The Encounter rates for blue sheep varied from 0.0 to 26.4 individuals/km walk and from 1.3 to 54.4 pellet groups/km walk (Table 2). Sarsopatal and north PA were ideal for blue sheep as evident by their pellet group counts which were 51.9 and 54.4 groups/Km walk respectively. The group size of blue sheep ranged from 4 to 61. All male groups were sighted on three occassions.

A total count of blue sheep was done at Sarsopatal for ten days between 27.5.93 and 12.6.93. The maximum number of blue sheep counted in any day is considered to be the minimum number that the area can hold. Table 4 gives results of the total counts made at Sarsopatal and north PA. The count of 91 for Sarsopatal and 128 for north PA are the maximum counted in any one day.

About 15 to 20 blue sheep kills were encountered in total in the PA. The causes of deaths were probably due to old age and predation.

### Himalayan Tahr

It was sighted on 10 occassions totalling 38 individuals. Five sightings (24 individuals) were in the Rishi Ganga gorge area between Chinwari (2,700m) and Dudh Ganga (2,880m). The rest were sighted in Dibrugeta (3,300 - 3,500m), Parkhurdhar (3,800 - 4,000m) and Deodi (3,300 - 3,500m) areas (Table 1, Fig.1). Four tahr kills were encountered between Kalikona (2,600m) and Malla Chinwari (2,800m). These tahr kills may be largely due to predation. The steep, precipitous cliffs with scattered tree and scrub in the gorge were found to be an ideal habitat for tahr. The encounter rates for tahrs sighted in the Chinwari - Malla Chinwari and Malla Chinwari - Dudh Ganga areas were relatively higher (Table 1), but their pellet group encounter rates were higher in the Kalikona - Chinwari and Chinwari - Malla Chinwari areas (Table 2). The occurrence of more tahr pellet groups in the lower areas of the gorge and their sightings in areas such as Dibrugeta and Deodi during June is due to their movement to higher altitudes following their stay in the lower areas during winter.

### Serow

One unconfirmed sighting of two serows at Dibrugeta and abundant evidences of serow in the same area were the only information that could be collected about this elusive mountain ungulate. A 0.5 Km survey line in the steep, densely forested slopes below Dibrugeta resulted in 7 pellet groups of serow (Encounter rate = 14/ Km walk). This area had dense montane bamboo as the ground cover. The lower rishi gorge area also appears to be ideal serow habitat.

**Snow leopard**

This highly endangered elusive cat was not seen during the survey but their evidences such as pugmarks, scrapes, scats and blue sheep kills were encountered commonly in Sarsopatal and north PA areas. The encounter rates for snow leopard in these two areas were 0.0 and 0.64 tracks/Km walk and 2.8 and 4.0 scats/ Km walk respectively (Table 2).

The only probable close encounter of snow leopard was the alarm calls of blue sheep and their flight through the Sarsopatal camp on 5*th* June, 1993 at 22.30 h.

As the range of common and snow leopard overlap in this area, the evidences encountered at and below tree line were considered to be either snow or common leopard as in the case of Bethartoli.

In total, 43 leopard scats were collected of which atleast 75% were of Snow leopard as they were collected in Sarsopatal and north PA areas.

**Common leopard**

The common leopard was not sighted but their evidences were encountered at the lower and fringes of this PA such as Kalikona and Lata kharakh (Table 2). The common leopard is well known for its predation on livestock in the villages of the Biosphere Reserve.

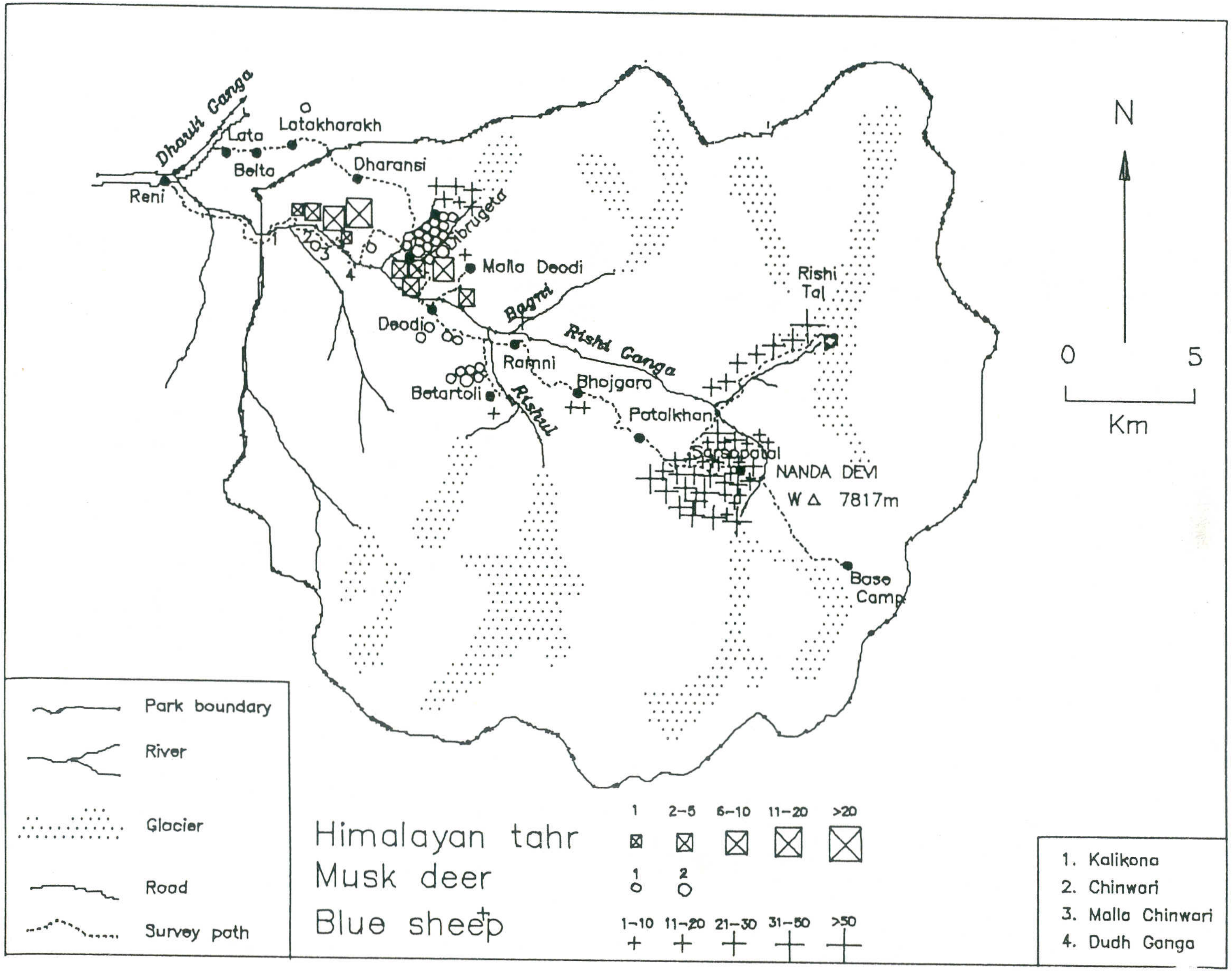
**Other mammals**

One sighting of **Himalayan yellow throated marten** at Ramni (Ravi Sankaran *pers comm.*), one sighting of **Himalayan Weasel** in the talons of a Golden Eagle in Trishul nullah area, one unconfirmed sighting of a **red giant flying squirrel** in Dibrugeta and many sightings of the **Himalayan mouse hare** or **pika** were had in the PA Three sightings of **Red fox** were had, of which one was between Patalkhan and Sarsopatal and two between Sarsopatal and Nanda Devi Base camp (V.K.Bhat, *pers comm*). (Table 3).

The goral *Naemorhaedus goral* was sighted once on the Murianda forest slopes opposite to Paing village (A. Rastogi *pers comm.*) outside the National Park. It is known to occur in the lower regions of the Biosphere But its presence in the PA is yet to be confirmed.

One red giant flying squirrel at Kalikona (T.S.Bisht *pers comm.*) and one Himalayan weasel in the Rishi Ganga gorge (Ajay Rastogi, *pers comm.*) were also sighted, but these areas are situated outside the PA. **Jackal** was sighted in the lower regions of the Nanda Devi Biosphere Reserve, outside the National Park. **Common langur** (Ravi Sankaran, *pers comm.*) was sighted outside the National Park (Table 3).

Fig. 1 Nanda Devi National Park showing locations of Himalayan Musk deer, Himalayan tahr and Blue sheep sightings



## DISCUSSION

The base line information on the status of mammals of this PA is from the surveys conducted by Z.S.I (Lamba, 1987; Tak & Kumar, 1987) a decade ago. The present survey (53 days in May -June) was short when compared to the earlier survey (167 days in June - October in 3 years) and as the seasons are also different, both these surveys are actually not comparable. However, an attempt is made to compare the results of the two surveys to assess the changes that have occurred when this PA had remained closed for human activities.

The status of musk deer and blue sheep appear to have improved while the status of tahr shows not much change. Blue sheep numbers have actually increased as clearly seen in the difference in number of sightings as well as total individuals seen (Table 5). As mentioned earlier, the wildlife habitats have recuperated from impacts due to human and livestock pressures. Increasing human and livestock impact has led to decreasing musk deer densities in Kedarnath Wildlife Sanctuary (Sathyakumar *et al.* in press *b*). The surveys conducted in Govind Wildlife Sanctuary, Uttar Kashi resulted in just two musk deer sightings and about fifty blue sheep (Sathyakumar, *unpubl.*) The major reason for low animal abundance in Govind Wildlife Sanctuary is due to human activity in the form of large scale mountianeering (Bander poonch, Swargarohini), trekking (Harkidoon, Ruinsara) and other biotic pressures. Ten years of protection after four decades of human impacts certainly allows some recuperation of the wilderness. The changes that has occurred and are expected to occur to this PA have important relevance to wildlife conservation in the Himalayas. The success achieved in protecting Nanda Devi National Park would serve as an example for a few other PAs in the Himalayas which have the potential to recover from human impact.

## RECOMMENDATIONS

### 1. COMPLETE PROTECTION TO THE NATIONAL PARK

Complete protection to any wilderness area has always resulted in maintaining the 'naturalness' and biodiversity. As Nanda Devi National Park represents an important biogeographic zone and being a World Heritage Site needs complete protection from all human activities such as mountaineering, trekking, livestock grazing, medicinal plant collection and poaching.

### 2. INFRASTRUCTURE - INCREASING MANPOWER

The existing setup of just 6 wildlife guards to patrol and protect a 2000 Km$^2$ rugged, steep, inhospitable terrain with poor equipment and logistics is a major draw back, particularly to control poaching. An improvement in the infrastructure is the need of the hour. Increase in man power who are well trained, motivated, provided with good equipment, incentives, logistics, awards for exemplorary field service and a good rapport with local villagers will help in efficient control of poaching and other illegal activities. The system of 'off season duty wildlife guards' in summer to remoter areas with minimal logistics was practised earlier in this part of the Himalaya. Such summer postings in some parts of the park boundary would help in controlling illegal activities. Though, the National Park is known to have two major entry points only, secondary information reveals that organised group of poachers do enter the park via Roint peak to Deodi and from Dewal via Roopkund to Bethartoli. These possible routes have to be carefully investigated and monitored

## 3. RESEARCH AND MONITORING

A fragile ecosystem as this with biodiversity values needs to be carefully monitored and managed. Longterm research and regular ecological surveys in different parts of the Biosphere Reserve will help in monitoring and providing the much needed data for management in the buffer areas. Gaston and Garson (1992) have conducted regular ecological surveys in the Great Himalayan National Park, Kullu District, Himachal Pradesh from 1980-81 to 1990-91 and presented results alongwith suggestions for its conservation and management. Such scientific surveys could be conducted atleast once in five years to monitor status of wildlife and their habitats in the Nanda Devi Biosphere Reserve.

## 4. ECO-TOURISM

As a National Park, this PA cannot cater to tourism. However; the areas just outside the PA, the buffer of the Biosphere Reserve has enough potential for wildlife and nature tourism. Maintenance of nature trails in the buffer zone can provide ample wildlife viewing to visitors and some income to the villagers who could be guides. This would help in creating an awareness among the local populace that wildlife watching and nature tourism would contribute to their annual income and thereby lead to their support to protect wildlife and their habitats.

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**Table 1. Major Ungulate sightings in Nanda Devi National Park, May - June, 1993.**

| SPECIES | LOCATION | NUMBER OF SIGHTINGS | TOTAL INDIVIDUALS |
|---|---|---|---|
| **MUSK DEER** | Malla Chinawari | 1 | 1 |
| *Moschus* | Dudh Ganga - Maltoni | 1 | 1 |
| *chrysogaster* | Dibrugeta | 14 | 16 |
| | Parkhurdhar | 2 | 3 |
| | Deodi | 4 | 4 |
| | Bethartoli | 5 | 6 |
| | Lata Kharakh | 1 | 1 |
| | | **28** | **32** |
| **BLUE SHEEP** | Dibrugeta & Deodi | 7 | 86 |
| *Psuedois* | Bagni gathera | 1 | 24 |
| *nayaur* | Bethartoli | 1 | 6 |
| | Bhojgara & Patalkhan | 3 | 7 |
| | North P.A. | 13 | 234 |
| | Sarsopatal | 38 | 633 |
| | | **63** | **990** |
| **TAHR** | Chinwari | 2 | 6 |
| *Hemitragus* | Malla Chinwari | 2 | 17 |
| *jemhalicus* | Dudh Ganga | 1 | 1 |
| | Dibrugeta | 3 | 8 |
| | Parkhurdhar | 1 | 5 |
| | Deodi | 1 | 1 |
| | | **10** | **38** |
| **SEROW** | Dibrugeta | 1* | 2 |
| *Capricornis* | | | |
| *sumatrensis* | | | |

* Unconfirmed

**Table 2. Encounter Rates of Major Mammals in Nanda Devi National Park, May - June, 1993.**

| Survey Route | Encounter Rates (#/Km Walk) | |
|---|---|---|
| | Sightings | Pellet groups |
| **Himalayan Musk Deer** | | |
| Malla Chinwari - Dudh Ganga | 0.2 | 0.0 |
| Dudh Ganga - Dibrugeta | 0.2 | 4.9 |
| Dibrugeta - Deodi | 0.0 | 2.2 |
| Deodi - Ramni | 0.2 | 4.2 |
| Ramni - Bethartoli | 0.0 | 2.0 |
| Lata kharakh - Belta kharakh | 0.0 | 0.8 |
| **Blue Sheep** | | |
| Dibrugeta - Deodi | 0.0 | 3.6 |
| Ramni - Patalkhan | 0.0 | 5.6 |
| Patalkhan - Sarsopatal | 1.8 | 51.9 |
| North PA bridge - Rishi Tal | 26.4 | 54.4 |
| Dharansi - Sathkula | 0.0 | 1.3 |
| **Himalayan Tahr** | | |
| Kalikona - Chinwari | 1.7 | 6.0 |
| Chinwari - Malla Chinwari | 3.5 | 4.7 |
| Malla Chinwari - Dudh Ganga | 2.4 | 0.6 |

| Survey Route | Encounter Rates (#/Km Walk) | |
|---|---|---|
| | Tracks | Scats |
| **Common Leopard** | | |
| Reni - Kali kona | 0.14 | 0.00 |
| Lata Kharakh - Belta Kharakh | 0.75 | 0.75 |
| **Common / Snow Leopard** | | |
| Ramni - Bethartoli | 0.22 | 0.22 |
| **Snow Leopard** | | |
| North PA bridge - Rishi Tal | 0.64 | 2.80 |
| Sarsopatal Transect | 0.00 | 4.00 |

**Table 3. Details of other Mammal sightings in Nanda Devi National Park, May - June, 1993.**

| SPECIES | LOCATION | NUMBER OF SIGHTINGS |
|---|---|---|
| Snow leopard<br>*Panthera uncia* | Sarsopatal,<br>North P.A. | Pugmarks, scats, kills<br>& other evidences seen |
| Common leopard @<br>*Panthera pardus* | Kalikona,<br>Lata kharakh | Pugmarks & scats seen |
| Goral @<br>*Naemorhaedus goral* | Murainda RF | One |
| Red Fox<br>*Vulpes vulpes* | Nanda Devi<br>base camp | Three |
| Himalayan Weasel<br>*Mustela sibirica* | Trishul nullah | one |
| Himalayan yellow throated Marten<br>*Martes flavigula* | Ramni | one |
| Red Giant Flying Squirrel*<br>*Petaurista petaurista* | Dibrugeta | one |
| Pika<br>*Ochotona royeli* | upto Ramni | Many |
| Common langur @<br>*Presbytes entellus* | Kalikona | one |
| Jackal @<br>*Canis aureus* | Reni - Lata . | one |

* Unconfirmed; @ Outside National Park

Table 4. Blue Sheep counts in Nanda Devi National Park, May - June 1993.

| **Date** | **Total Counted** | |
|---|---|---|
| **SARSOPATAL** | **No. of groups** | **No. of individuals** |
| 27.5.93 | 2 | 19 |
| 29.5.93 | 3 | 51 |
| 30.5.93 | 5 | 52 |
| 31.5.93 | 5 | 58 |
| 1.6.93 | 6 | 91 * |
| 2.6.93 | 2 | 31 |
| 9.6.93 | 3 | 76 |
| 10.6.93 | 5 | 80 |
| 11.6.93 | 4 | 77 |
| 12.6.93 | 3 | 54 |
| **NORTH P.A** | | |
| 30.5.93 | 4 | 73 |
| 2.6.93 | 3 | 33 |
| 3.6.93 | 4 | 128 * |

**Table 5. Comparison of this survey results with earlier surveys**

**Details of the surveys**

| | | | |
|---|---|---|---|
| **Conducted by** | - | **Z.S.I.** | **W.I.I** |
| **Years** | - | **1981 - 1984** | **1993** |
| **Months** | - | **June - October** | **May - June** |
| **Number of days** | - | **167** | **52** |

| **Species** | **No. of sightings** | **Total number seen** | **No. of sightings** | **Total number seen** |
|---|---|---|---|---|
| Musk deer | 14 | 27 | 28 | 31 |
| Himalayan Tahr | 9 | 55 | 10 | 38 |
| Blue sheep | 16 | 180 | 63 | 990 |
| Serow | 0 | 0 | 1* | 2 |
| Snow leopard | 4 | 4 | 0 | 0 |
| Himalayan Brown bear | 2 | ? | 0 | 0 |
| Himalayan Black bear | 9 | 12 | 0 | 0 |

* unconfirmed

# AN ORNITHOLOGICAL SURVEY OF NANDA DEVI NATIONAL PARK

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## INTRODUCTION

All wilderness areas in India are under siege from increasing human pressures. Thus for the conservationist, Nanda Devi National Park (NDNP) is an area that can be regarded with satisfaction, for it is perhaps one of the only protected areas in India that has been closed to all human use since 1982. However, human needs still had to be met, for much of the local populace were dependent on forest or grassland resources. thus in 1988 the Govt. of India established the Nanda Devi Biosphere Reserve (NDBR).

In 1993, the Ministry of Environment and Forests, Govt. of India, sponsored a survey into the core area of NDBR to assess whether 12 years of closure has had a positive impact on the status of the flora and fauna. I looked specifically at the avifauna.

## OBJECTIVES

1) To prepare a comprehensive list of the avifauna with specific reference to the habitats and altitudes they occurred at.

2) To assess the current status of rare species of avifauna.

## FIELD METHODS AND DATA COMPILATION

The line transect method (Burnham *et al.* 1987) was used to assess the status of Galliformes. However, in this report, due to lack of repetitions of the transects, only encounter rates of the focal species have been calculated.

Notes were maintained on all species of birds seen, particularly the habitats and locations they occurred in. I did not attempt measuring densities of the avifauna because a) many of the species were new to me and b) I was not able to immediately identify most species by their calls. It was felt that due to the above two factors, any calculation of density would be erroneous. However, I have given an abundance ranking for the species seen and this is based only on confirmed sightings or calls heard. In the abundance ranking, a flock was considered as a single sighting. Signs of use, for instance dig marks of the monal pheasant, or droppings of the snow cock were also noted to identify areas of their occurrence.

In this report, comparison of avian assemblages between habitat types and altitudanal zones have been done using a species richness indice where the species richness is the total number of bird species seen in a given habitat or atitude type.

A simple classification of habitat types were made. Alpine meadows consisted of tree-less alpine grasslands where woody species were mainly juniper *Juniperus* sp., dwarf rhododendron *Rhododendron anthopogon, Cassiope fastigiata,*.and *Salix karelini*. Subalpine forest were dominated by birch *Betula utilis*, fir *Abeis spectabilis*, or rhododendron *Rhododendron campanulatum*. Temperate forests were dominated by oak *Quercus* sp., blue pine *Pinus valletiana*, yew *Taxis baccata* and maple *Acer* sp.

Altitudes have been compiled from 1 : 50000 scale Survey of India topo sheets. Distances were measured using a pedometer whose setting had been adjusted for smaller strides.

In this report, I have included all birds seen by me from Joshimath onwards. The primary reason for this is that temperate oak forest that is present in the NDBR did not occur on the route that this expedition took. The only temperate oak forest that I was able to look at was that above Joshimath enroute to Auli. It is presumed that bird species that occurred at Auli would occur within those areas of the NDBR which has temperate oak forest. Furthermore, it is important to compare bird assemblages in habitats which are perhaps used for wintering and lie outside the NDNP.

The status of rare avifauna has been arrived at using two methods. The first of these was recording all sightings or calls and presenting these as a total in Table 3. This information is not to be mistaken as sightings of different indiviuals but the cumulative of sightings and calls heard in a given area. The next method used was of encounter rates which was derived from the number of individuals seen or heard per kilometer walk. This was done only for those species which were frequently seen or heard (monal and snowcock). As the time spent at different locations varied, in this report only encounter rates provide a comparative indice for abundance of different species at different locations.

## Study duration / Itinerary

This survey lasted 52 days from 2 May 1993 to 22 June 1993.

April 24 - May 1 : Joshimath. 3 visits to Auli
May 2 - May 6 : Rishi Ganga gorge. Reni - Kalikona - Chinwari (Chenabadi) - Malla Chinwari - Dood Ganga - Dibrugeta
May 7 - May 16 : Dibrugeta. Areas covered included Malla Dibrugeta, Dibrugeta maidan, Parkurdhar, forested areas below Dibrugeta maidan.
May 17 - May 19 : Deodi. Areas covered included slopes above Deodi camp and upto Malla Deodi.
May 20 - May 22 : Ramni. Areas covered included forest before Ramni and Bagni Gadera.

May 23 - May 24 : Bethartoli. Areas covered included 'bugyal' around camp and forest and 'bugyal' before and above Bethartoli.
May 25 - May 27 : Ramni - Patalkhan - Sarsonpatal
May 28 - May 29 : Sarsonpatal
May 30 : North Sanctuary
May 31 - June 1 : Sarsonpatal
June 2 - June 3 : North Sanctuary & Rishi 'tal'
June 4 - June 5 : Sarsonpatal
June 6 - June 7 : Nanda Devi Base camp
June 8 - June 10 : Sarsonpatal
June 11 - June 12 : Sarsonpatal - Ramni - Dibrugeta
June 13 - June 16 : Dibrugeta
June 17 - June 19 : Latha Kharak
June 20 - June 21 : Belta Kharak
June 22 : Belta Kharak - Reni (road head)

## RESULTS & DISCUSSIONS

### Distribution patterns

During this survey, a total of 114 species were recorded belonging to 30 families (Appendix 1 & 2). The family Turdidae (thrushes & chats) appears to be the most dominant (21 species) followed by Sylviidae and Fringillidae (11 species each) and Corvidae (9 species). Of the 114 species recorded 84 species were recorded within the NDBR and 30 species were recorded around Joshimath and the oak forest at Auli (Appendix 2).

There were three earlier expeditions for which bird lists are available from this area (Reed 1979, Casebolt 1979, Tak & Kumar 1987). 78 species of birds seen by them and not seen by me are listed in Appendix 3 (67 species were recorded by me and not by the earlier expeditions, of which 33 were from NDNP). Of the 78 species listed in Appendix 3, 57 were recorded within the National Park. Thus the total number of species recorded from within the NDNP and parts of the Biosphere Reserve is 141.

During this survey 4 major habitat types were surveyed. These were temperate forests, sub-alpine forests, alpine meadows and water courses.

Species richness was found to be highest in temperate forests with 47 species recorded within it, 24 of which were seen only in this habitat (Table 1). The species richness of temperate forest is likely to be much higher as this habitat type was the least surveyed of all habitat types, and consisted only of three 2 to 5 hour visits to Auli, and a single 3 hour survey of Belta Kharak. Birds were found to be the most abundant in this habitat type.

Sub-alpine forest ranked the next highest in species richness with 43 species recorded there, 18 of which were only seen in that habitat type (Table 1). This habitat type along with the next were the most intensively surveyed areas during this survey.

33 species were recorded in alpine meadows of which 10 were seen exclusively in this habitat type (Table 1).

Table 1.
Distribution of bird species among different habitat types

| | Habitat Type | Total species | Exclusive species |
|---|---|---|---|
| 1 | Alpine meadow | 33 | 10 |
| 2 | Sub-alpine forest | 43 | 18 |
| 3 | Upper temperate | 47 | 24 |
| 4 | Water courses / bodies | 7 | 6 |
| 5 | Cliffs | 14 | 3 |
| 6 | Boulder strewn slopes with sparse vegetation | 6 | 3 |
| 7 | Agriculture / habitation | 20 | 8 |

Of the 114 species recorded 42 (37%) were seen exclusively in forest either dominated by oak, fir, birch or rhododendron. Only 20 species (8 exclusively) were recorded in degraded forest and agriculture lands and 10 (8.7 %) were exclusive to alpine meadows. This could indicate that the majority of the species in the areas surveyed are specialists that require primary forest cover. I could not examine alpine meadows that are subjected to human activity and thus am unable to assess the impact of degradation / disturbance on the avifauna of that habitat type.

The altitudinal distribution of the avifauna is given in Table 2. There was a significant decline in species richness (and apparently of abundance) as elevation increased. Only 1 species spanned the entire altitudinal range; this was the brown dipper Cinclus pallasi of which I had a glimpse at the lake at base camp. The decline in species richness with increasing altitude is concurrent with the distributional patterns of avifauna with habitat (Table 1). Temperate forests generally occurred below 2800 m msl, sub-alpine forests between about 3000 m msl - 3800 m msl and alpine meadows between 3800 m msl and 5000 m msl.

These findings are concurrent with similar studies done on the avifauna of the Himalayas (for e.g. Katti *et al.* 1992).

Table 2.
Distribution of bird species according to altitude

| Altitude | Total species | Species Overlap | | | | |
|---|---|---|---|---|---|---|
| 4800-5800 | 4 | | 3 | | | |
| | | | | | 1 | |
| 3800-4800 | 28 | | | | | |
| | | 8 | | | | 1 |
| 2800-3800 | 51 | | | 8 | | |
| | | | 18 | | | |
| 1800-2800 | 66 | | | | | |

**Notes on the observed movement patterns of birds**

Our survey began during very early spring and ended by early summer. This perhaps accounted for the absence of many species of birds which I expected to see, for example the buntings. When the survey commenced, May 2, leafing of birch (the dominant sub-alpine tree species) had only just begun and even snow fall occurred a few times during this period. It was obvious that the immigration into alpine and sub-alpine areas had only just commenced.

The most abundant of the first arrivals appear to be Phylloscopus warblers, crested black tit *Parus melanolophus*, yellow-bellied fantail flycatcher *Rhipidura hypoxantha*, orange flanked bush robin *Erithacus cyanurus*, bluefronted redstart *Phoenicurus frontalis*, Indian tree pipit *Anthus hodgsoni* and vinaceous breasted pipit *Anthus roseatus*. Three species of Corvidae, yellowbilled chough *Pyrrhocorax graculus*, redbilled chough *P. pyrrhocorax* and jungle crow *Corvus machrorynchos* and one Columbidae, the snow pigeon *Columba leuconota* were commonly seen.

Abundance of avifauna was low, and though territories were being established (for e.g. crested black tits were exceedingly vocal at Dibrugeta) this appeared to be an inconsistent activity among species generally. Many birds seemed to cover larger areas in search of food (for e.g. the yellow- bellied fantail flycatcher). Some species, notably the tits (green backed and crested black) and the orange flanked bush robin had commenced nesting as was evidenced by individuals observed with nesting material (hair/fur of tahr and musk deer).

I expected to see a substantial change in species richness with the onset of warmer weather and the emergence of vegetation. This did not occur. The only apparent change was a considerable increase in bird abundance, but species richness did not increase dramatically. Later arrivals (some of which did exist earlier in low numbers) included some species of rosefinch (e.g. common rosefinch *Carpodacus erythrinus*) and the nutcracker *Nucifraga caryocatactes*, the latter being the most conspicuous late immigrant. Some Phylloscopus warblers also appeared to immigrate into sub-alpine forests later, for instance the largebilled leaf warbler *Phylloscopus magnirostris*. Enroute to Sarsonpatal, this species was recorded only at Deodi, in the sub-alpine birch/fir forest alongside the Rishi Ganga river (May 17 - May 19). During the return journey, I found it to be common at Dibrugeta. Similarly, between May 7 - May 16 I had only one sighting of the large bush warbler *Cettia major* at Dibrugeta while between 13 June and June 16 I came across this species 7 - 8 times. (The large bush warbler was also interesting because it occurred in a very small patch < 10 ha. of alpine meadow with cotton easter and rose bushes only. I did not come across this species elsewhere).

The only plausible explanation I have is that the sub-alpine forests of NDNP are cut off from forested areas of lower elevations by a ring of high mountains over 4500 m msl. The only forested inlet into the core area is the Rishi Ganga gorge. However, the forest is not contiguous, and often broken by steep cliffs along the gorge. This could perhaps be why many species, for example laughing thrushes do not ascend to the sub-alpine forests within the core area because of the lack of contiguous forest through which to move.

Birds immigrate into the sub-alpine and alpine areas to breed in the resource rich habitats of summer (Ali & Ripley 1983). On the return journey, early June onwards, many individuals of several species were seen carrying food or nesting material in the sub- alpine forest indicating that breeding was well under way. A nest of the orangeflanked bush robin was seen in a cavity in the ground below a tussock of grass in fir dominated forest.

## Status of Galliformes

The Himalayas are inhabited by a great diversity of gallinaceous birds that include 13 species of pheasant, 10 partridges and at least 3 species of quail (Ali & Ripley 1993). During this survey, I recorded the presence of 5 species, Snow partridge *Lerwa lerwa*, Himalayan snowcock *Tetraogallus himalayensis*, Black partridge *Francolinus francolinus* Monal pheasant *Lophophorus impejanus* and Koklas pheasant *Pucrasia macrolopha* and reliably learnt of the existence of three more species Chukar partridge *Alectoris chukar* Kaleej pheasant *Lophura leucomelana*, Chir pheasant *Catreus wallichii*.

The sightings of Galliformes during this survey are given in Table 3 and a comparison is made with the Z.S.I surveys between 1981-84 in Table 4. The problem of comparing the two data sets is that Lamba (1987) has not stated the locations of sightings. Thus I only compare total numbers recorded.

Table 3

Status of Galliformes in Nanda Devi National Park

| Species | Location | Total seen/heard | Encounter rate/km |
|---|---|---|---|
| Monal | Maltoni pass | 3 | - |
| | Dibrugeta | 81 | 4.7 |
| | (Dibrugeta | 16) | |
| | Deodi | 5 | 1.25 |
| | Deodi-Ramni | 2 | 0.4 |
| | Bagni Gadera | 1 | 0.8 |
| | Ramni-Bethartoli | 2 | 0.4 |
| | Bethartoli | 3 | 0.6 |
| | Dibrugeta-Dharansi | 2 | - |
| | Latha Kharak | 3 | - |
| | Belta Kharak | 3+ | |
| Koklas | Dibrugeta | 2 sightings<br>(14 times heard) | |
| Snow partridge | Dibrugeta | Heard twice | |
| | Sath kula | 1 | |
| Himalayan snowcock | Pathalkhan | 1 | |
| | Sarsonpatal & | 28 sightings | 2.8 |
| | North sanctuary | >60 calls | 2.4 |

n.b. Numbers are sums of all sightings / calls heard and are irrespective of repetitions over subsequent days. Paranthesis are sightings on return journey.

Fig. 1. Nanda Devi National Park with sighting locations of Gallinaceous birds.

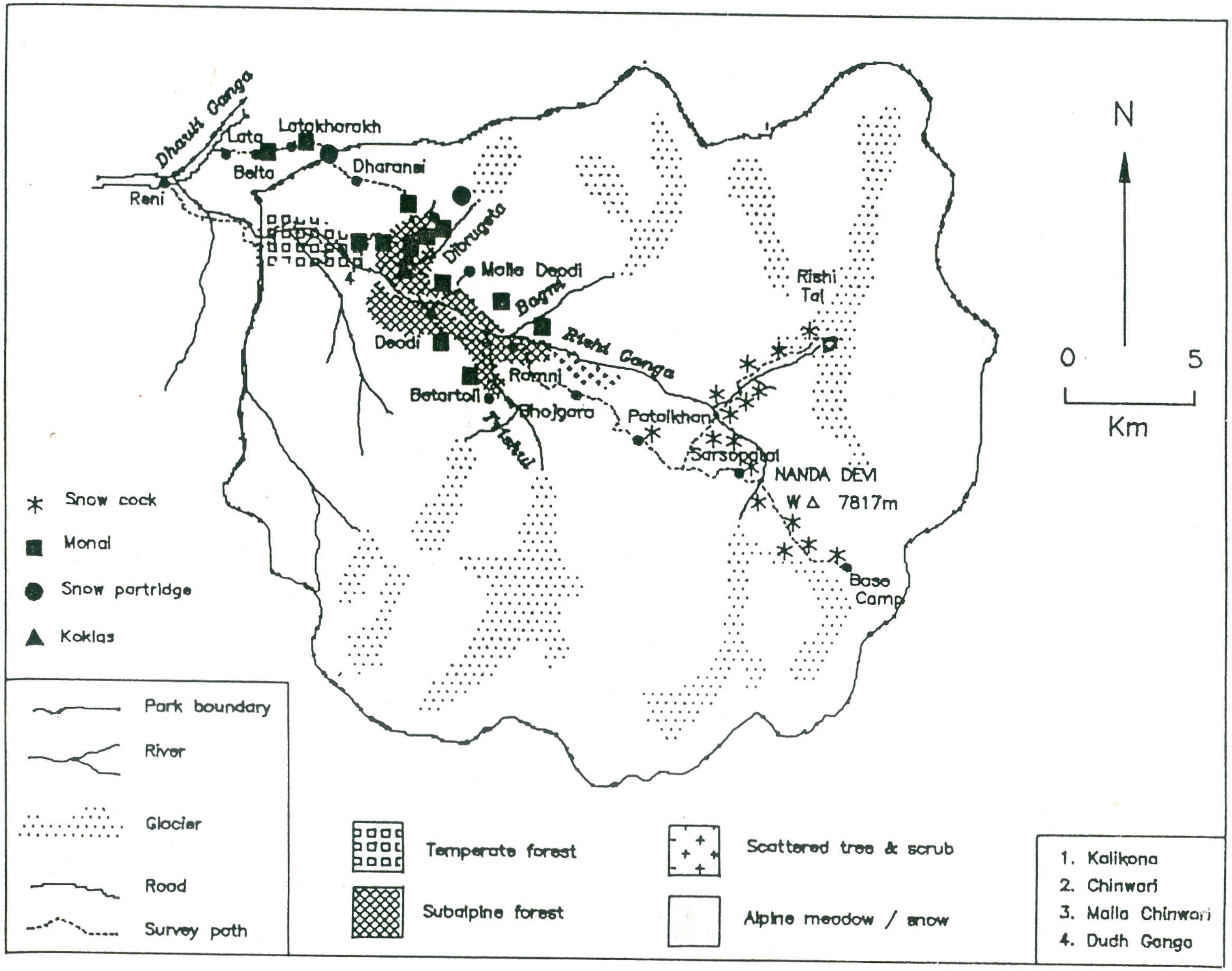

Table 4

Comparison of sightings of Galliformes in NDNP

| Species | This study | Lamba 1987 |
|---|---|---|
| Himalayan snow cock | 28 sightings<br>>60 calls | 11 (49) |
| Monal | 121 (including calls) | 34 (63) |
| Koklas | 2 sightings<br>14 calls | 15 (48) |

Lamba (1987) : nos = number of observations
( ) = total individuals seen

1. Snow partridge *Lerwa lerwa*

I heard this bird twice at Dibrugeta in the rocky area above the meadow at an altitude of about 4000 m. I guessed that a covey of 4 - 6 birds occurred there. I sighted one individual beyond 'Sat Kula' enroute to Lata Kharak. 5 days later Trilok Singh Bisht, Wildlife Guard, saw a bird with chicks at exactly the same place. I believe this species to be uncommon in NDNP, though Khacher (1978) found them to be 'plentiful'.

2. Chukor partidge *Alectoris chukar*

Though not seen during this survey ithis species is present in agriculture lands in the NDBR.

3. Black partridge *Francolinus francolinus*

This species was heard frequently around Joshimath in agriculture lands and appeared to be present in good numbers.

4. Himalayan snowcock *Tetraogallus himalayensis*

This bird was frequently seen from Pathalkhan (4100 m) onwards, and occurred as high as Camp 2 (5900 m). I found them to be very shy and those birds that were flushed at Sarson Patal invariably flew across the river and landed on the steep rocky cliffs at the base of the Nanda Devi Mountain. They occurred at similar densities in the North Sanctuary (Table 3).

A comparison of data available does not reveal a significant change in the population of this species between 1981/84 and 1993 (Table 4). However, the duration of time spent in the area was considerably less by me than by Tak & Kumar (1987). Thus, it is probable that numbers of this species has increased. Alternately it is possible that the lack of disturbance has resulted in more birds using Sarson Patal meadow.

Some expeditions have reported the presence of Tibetan snowcock *Tetraogallus tibetanus* in NDNP (Reed 1979, Casebolt 1979), and Ali & Ripley (1983) have said that the range extends upto Nanda Devi. None of the individual that I had good looks at were Tibetan snowcock. However, the birds around Base Camp seemed to have slightly different calls from those at Sarsonpatal. The existence of Tibetan snowcock in NDNP needs confirmation.

5. Western tragopan *Tragopan melanocephalus*

Tak & Kumar (1987) suspected the presence of this bird in NDNP. I did not see or hear any and inquiries amongst the locals also did not result in any information on this species. I believe that this species does not exist in NDNP.

This species is the rarest pheasant in western Himalayas (Gaston et al. 1981) and its range apparently ends west of Nanda Devi (Hume & Marshall 1879, Delacour 1977, Ali & Ripley 1983).

6. Monal pheasant *Lophophorus impejanus*

This pheasant was the most common Galliform in NDNP. Upto 10 or males could be sighted at Dibrugeta meadow in the early morning or late evening hours. Females were less frequently seen, perhaps because nesting had commenced. (One female with chicks was seen enroute to Bethartoli on 20 May 1993; V.K. Pangtey pers. comm.). Monal were less frequently seen elsewhere in NDNP, but a few occurred at the tree line throughout the survey route excepting at Bhujgara. The lowest altitude monal was seen at was at Belta Kharak (2800 m msl) where 2 females and one male were sighted and were heard a few times as well.

There appears to have been a distinct increase in the population of monal in NDNP. Between 1981 and 1984 six expeditions totaling 167 days were made to NDNP by Tak and Kumar (1987). Only 63 individuals were sighted by them (Lamba 1987), whereas in less than 35 days in monal habitats, I sighted or heard monal on more than 121 occasions. Khachcher (1978) did not see any monal during his survey in 1977, though he documented the presence of suitable habitats. Thus absolute protection has certainly benefited this species.

7. Kaleej pheasant *Lophura leucomelana*

Not seen during this survey, but is present at Belta Kharak, and in forested areas around Lata and Reni village. Its status there is unknown and it seems that some amount of hunting pressures exist on this species.

8. Koklas pheasant *Pucrasia macrolopha*

A rare bird within NDNP. Occurred only in the forested area below Dibrugeta maidan. A single sighting by me and one by the wildlife guards were the only two records of this species during this survey. However, this bird was heard atleast on 14 different occasions and the maximum number of individuals that I heard was five. The feathers of a female pheasant found between Kalikona and Chinwari was possibly of this species.

Has the Koklas reduced in number? Lamba (1987) recorded koklas on 15 occasions with a total of 48 individuals. However, as he has not given location of sightings a comparison can not be made. Khachcher (1978) heard them at above Lata village, an area I did not survey. Locals confirmed their continued presence in the area.

9. Chir pheasant *Catreus wallichii*

Not seen during this survey. This pheasant occurs in the forested areas near Reni village and like other pheasants that occur near villages appear to be under some hunting pressures. Possibly one individual was heard at Belta Kharak (Negi, AWLW, pers. comm.).

It is unlikely that chir exist within NDNP as they avoid forested areas but are often found in association with agriculture (Garson et al. 1992).

### Status of Raptors

My sightings of raptors were few (Appendix 2), and only the Himalayan griffon *Gyps fulvus* and the lammergeier *Gypaetus barbatus* were seen frequently. Presumably an influx of raptors into the surveyed areas would occur only when immigration of avifauna into alpine and sub-alpine areas reaches its peak or the maximum emergence of rodents after winter hibernation (for e.g. though pika *Ochotona royeli*was seen in a number of locations populations were low) would result in an adequate prey base.

### Conservation

I classify the conservation perspective in this report into four main categories, namely those pertaining to NDBR, Research Priorities, implications to western Himalayas and Auli.

### 1. Nanda Devi Biosphere Reserve

The NDBR in reality needs to be treated as two separate units. The core area or Nanda Devi National Park and the Buffer Zone of NDBR.

## 1.1. Nanda Devi National Park

Perhaps the ultimate achievement of protection of nature in India is the absolute ban of human use within the protected area. A ban on human use has been in effect in NDNP since 1982. I believe that this ban should not be lifted because the evidence collected during this survey more than amply proved the increase in rare avifauna and mammals in the intervening years.

We did come across signs of illicit entry into the NDNP. Some signs were of collectors of plants of commercial value, while others were apparently of poachers. Infact, signs of probably poached (sic) musk deer were seen at a few sites (see also Sathya Kumar, this report). However, poaching pressures appear to be minimal or occurs rarely as evidenced by the frequency and numbers of animals seen; I had about 20 sightings of musk deer (see also Sathya Kumar, this report).

The only way to stop or further reduce the existing musk deer poaching pressures is to have regular patrols by armed wildlife guards. I am against this because :

a) The idea of a total ban in Nanda Devi is to prevent totally the entry of humans into the core zone.

b) The constant patrolling of guards along with their logistic support can be a disturbance in key wildlife areas.

c) Bridges etc. that will have to be constructed for the guards can just as well be used by poachers.

d) Patrolling can only minimise poaching; cannot eradicate it as is evidenced from examples all over India where commercially important animals exist (the Indian Rhino and Asian elephant are classical examples). I believe that poaching pressures in Nanda Devi National Park are minimal and do not warrant the disturbance levels that can be caused by regular armed patrols with necessary logistic support. I also doubt whether patrols can eradicate poaching.

e) However, the traditional entry points to the NDNP should be closely gaurded, to deter possible illegal entry.

A monitoring survey once every five or more years can be made to assess status of mammals and birds. There was no indication during the current survey that patrolling or any other management practice needs implementation within NDNP.

Nanda Devi National Park is a success story of the Uttar Pradesh Forest Department. If permits for expeditions are granted in future, it will defeat the essence of NDNP. It is hoped that the Government of India will be able to withstand the pressures that is bound to come due to this one time permit (1993 expedition) that was granted.

No more permits to mountaineering or trekking expeditions.

### 1.2 Buffer Zone of NDBR

The Buffer of NDBR is a multiple use area, where needs of nearby villages are met, e.g. fuel and fodder. The only area of the Buffer Zone that we covered during this survey were Lata Kharak and Belta Kharak.

Several areas of the Buffer Zone are rich in wildlife. These are easily accessible. Information was gathered on probable hunting pressures and excessive or unsustainable collection of plants of commercial value.

The need in NDBR is not to waste valuable resources and personnel on the NDNP (which is in excellent condition) but to increase strength of personnel and patrolling in the wildlife rich areas of the Buffer Zone and adjacent areas and inculcate sustainable exploitation of plants of economic value amongst the locals.

## 2. Research Priorities

There is scope for much research in the NDBR. However research activities must not be permitted within the NDNP or core zone of the NDBR. I base this on the following arguments.

a) Permanent field stations can be a source of disturbance, and will be a source of human interference. The purpose of banning entry into NDNP was to prevent human influence in toto in the area. Thus any source of human activity, for e.g. permanent or temporary research stations should not be permitted within NDNP.

b) Since NDNP recieves total protection, no obvious conservation problems were seen during this survey. Thus research for 'management' or conservation of the area is not required.

c) Research activity as with all other human activity should be restricted to the buffer zone only.

## 3. Conservation of avifauna in western Himalayas

I base this section on scanty data, having no information on the status of forested land in the area as a whole.

Almost all species of avifauna in the Himalayas show altitudinal migration, ascending into sub-alpine and alpine areas in summer to breed and descending into temperate and tropical areas in the winter when snow and extreme climatic conditions create a resource crunch at higher altitudes (Ali & Ripley 1983).

The lower temperate and tropical forests of the Himalayas are perhaps amongst the most vulnerable in this biogeographic zone simply because this is the inhabited belt. It is in the lower temperate and tropical belt that maximum deforestation is taking place (D. Mohan pers. comm.).
Apparently, most protected areas in western Himalayas are situated at higher altitudes, encompassing mostly alpine or sub-alpine areas. Do these protected areas have sufficient temperate and tropical forest below them

into which birds can descend during winter ?

Thus, I argue that it is necessary for a protected area network around and below high altitude Protected Areas. These should encompass forested and other areas at lower altitudes which are used for wintering by birds. Lack of sufficient protection of wintering areas will result in reduction in the populations that migrate into Alpine or sub-alpine areas to breed in.

### 4. Auli

Inspite of the fact that during this survey the forests at Auli (above Joshimath) were the least surveyed, it was the richest bird habitat that was seen in the entire expedition. I propose that a specific survey/study is made to find ways and means by which to better protect this excellent forest.

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Appendix 1

Classification of birds seen according to families

| | | | | |
|---|---|---|---|---|
| 1 | Accipiteridae | 6 | | |
| 2 | Falconidae | 2 | | |
| 3 | Phasianidae | 5 | | |
| 4 | Columbidae | 5 | | |
| 5 | Cuculidae | 1 | | |
| 6 | Caprimulgidae | 1 | | |
| 7 | Apodidae | 2 | | |
| 8 | Upupidae | 1 | | |
| 9 | Captonidae | 1 | | |
| 10 | Picidae | 3 | | |
| 11 | Lannidae | 1 | | |
| 12 | Dicruridae | 1 | | |
| 13 | Corvidae | 9 | | |
| 14 | Campephagidae | 1 | | |
| 15 | Pycnonotidae | 2 | | |
| 16 | Muscicapidae | 41 | Timalinae | 4 |
| | | | Muscicapinae | 4 |
| | | | Sylviinae | 11 |
| | | | Turdinae | 21 |
| 17 | Troglodytidae | 1 | | |
| 18 | Cinclidae | 1 | | |
| 19 | Prunellidae | 3 | | |
| 20 | Paridae | 5 | | |
| 21 | Sittidae | 1 | | |
| 22 | Certhidae | 2 | | |
| 23 | Motacillidae | 3 | | |
| 24 | Dicaeidae | 1 | | |
| 25 | Zosteropidae | 1 | | |
| 26 | Ploceidae | 1 | | |
| 27 | Fringillidae | 11 | | |

## APPENDIX 2

### Annotated list of the birds of Nanda Devi National Park (including birds at Joshimath & Auli)

| No. | Species | | Locations | Habitat | Altitudes | Abundance ranking | Outside reserve |
|---|---|---|---|---|---|---|---|
| 1 | Sparrow-hawk | *Accipiter nisus* | Dibrugeta | 2,1 | 3500 | 2 | |
| 2 | Longlegged buzzard | *Buteo rufinus* | Maltoni pass, Malla Dibrugeta | 2,1 | 3900 | 2 | |
| 3 | Booted hawk-eagle | *Hieraaetus bennatus* | Rishi Ganga gorge, above Bethartoli ? | 3,1,5 | 2600-3900 | 2 | |
| 4 | Himalayan golden eagle | *Aquila chrysaetos* | Above Trisul nalla & Rishi ganga confluence; Sarsonpatal | 1,2 | 3700-4200 | 2 | |
| 5 | Himalayan griffon | *Gyps himalayensis* | Reni / Latha to Sarsonpatal | 1,2;3,5 | 2000-4500 | 6 | |
| 6 | Lammergeier | *Gypaetus barbatus* | Dibrugeta to Sarsonpatal | 1,2,5 | 3500-4500 | 4 | |
| 7 | Falcon sp. | *Falco sp.* | Doodganga | 5 | 2800 | 1 | |
| 8 | European kestrel | *Falco tinnunculus* | Dibrugeta to Ramni, Bethartoli | 1,5 | 3500-3600 | 3 | |
| 9 | Snow partridge | *Lerwa lerwa* | Above Dibrugeta, 'Sath kula' | 1,6 | 4000 | 2 | |
| 10 | Himalayan snowcock | *Tetraogallus himalayensis* | Pathalkhan, Sarsonpathal, N. sanctuary, base camp upto 'camp II' | 1,5 | 4100-5900 | 4 | |
| 11 | Black partridge | *Francolinus francolinus* | Around Joshimath | 7 | 2000-2300 | 4 | + |
| 12 | Himalayan monal pheasant | *Lophophorus impejanus* | Belta Kharak to Ramni | 2,3,1 | 2800-3900 | 5 | |
| 13 | Koklas pheasant | *Pucrasia macrolopha* | Dibrugeta | 2 | 3500 | 3 | |
| 14 | Snow pigeon | *Columba leuconota* | Doodganga & above | 1,2,5 | 2800-4500 | 6 | |
| 15 | Blue rock pigeon | *Columba livia* | Around Joshimath | 7 | 2000 | - | + |
| 16 | Hill pigeon | *Columba rupestris* | Near Bethartoli | 6 | 3700 | 1 | |
| 17 | Speckled wood-pigeon | *Columba hodgsonii* | Reni, Kalikona, Belta khadak | 3 | 2100-2900 | 4 | |
| 18 | Rufous turtle dove | *Streptopelia orientalis* | Beltakhadak, Auli around Joshimath | 3,7 | 2000-2700 | 4 | |
| 19 | Cuckoo | *Cuculus canorus* | Dibrugeta to Reni | 2,3 | 2000-3900 | 3 | |
| 20 | Himalayan jungle nightjar | *Caprimulgus indicus* | Belta Kharak | 3 | 2800 | 1 | |
| 21 | Himalayan swiftlet ? | *Collocalia brevirostris* | Rishiganga gorge | 5 | 2000-2500 | - | |
| 22 | Large whiterumped swift | *Apus pacificus* | Rishiganga gorge | 5 | 2000-2800 | 5 | |
| 23 | Hoopoe | *Upupa epops* | Around Joshimath, Auli | 7,3 | 2000-2700 | 3 | + |
| 24 | Great hill barbet | *Megalaima virens* | Auli | 3 | 2300-2700 | 4 | + |
| 25 | Sapsucker | *Hypopicus hyperythrus* | Auli | 3 | 2300-2700 | 2 | + |
| 26 | Himalayan pied woodpecker | *Picoides himalayensis* | Auli | 3 | 2300-2700 | 3 | + |
| 27 | Woodpecker sp. | *Picoides ? sp.* | Dibrugetta | 2 | 3500 | 2 | |
| 28 | Rufousbacked shrike | *Lanius schach* | Above Joshimath, Auli | 7,3 | 2000-2500 | 4 | + |
| 29 | Ashy drongo | *Dicrurus leucophaeus* | Around Joshimath | 7,3 | 2000 | 4 | + |
| 30 | Common mynah | *Acridotheres tristis* | Around Joshimath | 7 | 2000 | 4 | + |
| 31 | Redcrowned jay | *Garrulus glandarius* | Auli | 3 | 2500 | 2 | + |
| 32 | Blackthroated jay | *Garrulus lanceolatus* | Auli | 3 | 2500 | 1 | + |
| 33 | Redbilled blue magpie | *Cissa erythrorhyncha* | Auli | 3 | 2700 | 2 | + |
| 34 | Himalayan tree pie | *Dendrocitta formosae* | Auli | 3 | 2500 | 1 | + |
| 35 | Nutcracker | *Nucifraga caryocatactes* | Reni / Latha to Ramni | 2,3,1 | 2200-3700 | 4 | |
| 36 | Yellowbilled chough | *Pyrrhocorax graculus* | Above Ramni to Sarsonpatal | 1,2,5 | 4000-5900 | 6 | |
| 37 | Redbilled chough | *Pyrrhocorax pyrrhocorax* | Maltoni pass to Pathalkhan | 1,2,5 | 3700-4100 | 6 | |
| 38 | House crow | *Corvus splendens* | Around Joshimath | 7 | 2000 | - | + |
| 39 | Jungle crow | *Corvus machrorynchos* | Joshimath to Dibrugeta | 1,2,3,5,7 | 2000-3700 | 5 | |
| 40 | Longtailed minivet | *Pericrocotus ethologus* | Auli | 3 | 2200-2700 | 3 | + |
| 41 | Whitecheeked bulbul | *Pycnonotus leucogenys* | Around Joshimath | 7 | 2000-2100 | 5 | |

| No. | Species | | Locations | Habitat | Altitudes | Abundance ranking | Outside reserve |
|---|---|---|---|---|---|---|---|
| 42 | Black bulbul | *Hypsipites madagascariensis* | Auli | 3 | 2300-2700 | 4 | + |
| 43 | Variegated laughing thrush | *Garrulax variegatus* | Beltakhadak, Auli | 3 | 2300-3000 | 4 | |
| 44 | Streaked laughing thrush | *Garrulax lineatus* | Around Joshimath | 7,3 | 2300-2700 | 5 | |
| 45 | Barthroated siva | *Minla strigula* | Dibrugeta, Deodi | 2 | 3300-3500 | 2 | |
| 46 | Blackcapped sibia | *Heterophasia capistrata* | Auli | 3 | 2400-2800 | 2 | + |
| 47 | Orange gorgetted flycatcher | *Muscicapa stophiata* | Deodi, Trishul nallah & Rishiganga confluence | 2 | 3300-3500 | 2 | |
| 48 | Whitebrowed blue flycatcher | *Muscicapa superciliaris* | Belta Kharak | 3 | 2900 | 1 | |
| 49 | Greyheaded flycatcher | *Culicicapa ceylonensis* | Auli | 3 | 2300-2700 | 2 | + |
| 50 | Yellowbellied fantail | *Rhipidura hypoxantha* | Maltoni to Ramni<br>flycatcher | 2 | 3400-3800 | 5 | |
| 51 | Paradise flycatcher | *Terpsiphone paradisi* | Above Joshimath, | 3,7 | 2000 | 2 | + |
| 52 | Strongfooted bush warbler | *Cettia montana* | Belta Kharak, around Joshimath | 7,3 | 1800-2800 | 5 | |
| 53 | Large bush warbler | *Cettia major* | Dibrugeta | 1 | 3600 | 3 | |
| 54 | | *Cettia sp.* | Above Bethartoli | 1 | 4400 | 1 | |
| 55 | Olivaceous leaf warbler | *Phylloscopus griseolus* | Sarsonpatal | 1 | 4200 | 2 | |
| 56 | Pallas's leaf warbler | *Phylloscopus proregulus* | Doodganga | 2,3 | 2800 | 1 | |
| 57 | Largebilled leaf warbler | *Phylloscopus magnirostris* | Deodi, Dibrugeta Belta Kharak | 2,3 | 2800-3600 | 4 | |
| 58 | Dullgreen leaf warbler | *Phylloscopus trochiloides* | Dibrugeta | 2 | 3500 | 2 | |
| 59 | Largecrowned leaf warbler | *Phylloscopus occipitalis* | Rishi Ganga gorge, Belta Kharak | 3,2. | 2200-2800 | 3 | |
| 60 | Blyth's leaf warbler | *Phylloscopus reguloides* | Dood Ganga, Dibrugeta | 2,3 | 2800-3600 | 3 | |
| 61 | Blackbrowed flycatcher-warbler | *Seicercus burkii* | Dibrugeta | 2 | 3600 | 3 | |
| 62 | Greyheaded flycatcher-warbler | *Seicercus xanthoschistos* | Doodganga | 3 | 2800 | 1 | |
| 63 | Goldcrest | *Regulus regulus* | Dibrugeta | 2 | 3600 | 3 | |
| 64 | Himalayan rubthroat | *Erithacus pectoralis* | Bethartoli, Sarsonpatal | 1,6 | 4100-4200 | 2 | |
| 65 | Blue chat | *Erithacus brunneus* | Maltoni pass | 2 | 3800 | 1 | |
| 66 | Orangeflanked bushrobin | *Erithacus cyanurus* | Maltoni to Ramni Belta khadak | 2,3 | 2800-3900 | 5 | |
| 67 | Blueheaded redstart | *Phoenicurus caerulocephalus* | Belta Kadak | 3 | 2900 | 2 | |
| 68 | Black redstart | *Phoenicurus ochruros* | Sarsonpatal | 1 | 4200 | 1 | |
| 69 | Bluefronted redstart | *Phoenicurus frontalis* | Dibrugeta to Sarsonpatal | 2,1 | 3500-4300 | 5 | |
| 70 | Plumbeous redstart | *Rhyacornis fuliginosus* | Kalikona | 4 | 2600 | 2 | |
| 71 | Hodgson's grandala | *Grandala coelicolor* | Sarsonpatal | 1 | 4300 | 1 | |
| 72 | Little forktail | *Enicurus scouleri* | Dibrugeta | 4 | 3500 | 1 | |
| 73 | Spotted forktail | *Enicurus maculatus* | Above Joshimath, Auli | 4 | 2000-2400 | 2 | + |
| 74 | Collared bush chat | *Saxicola torquata* | Around Joshimath | 7 | 2000 | 4 | + |
| 75 | Dark-grey bush chat | *Saxicola ferrea* | Around Joshimath | 7 | 2000 | 4 | + |
| 76 | Whitecapped redstart | *Chaimarrornis leucocephalus* | Reni to Sarson Pathal | 4 | 2000-4200 | 5 | |
| 77 | Blueheaded rock thrush | *Monticola cinclorhynchus* | Above Joshimath | 3,7 | 2000-2400 | 2 | + |
| 78 | Blue whistling thrush<br>Bethartoli | *Myophonus caeruleus* | Reni to Ramni, | 4,5;1 | 2000-3800 | 6 | |
| 79 | Plainbacked mountain thrush | *Zoothera mollissima* | Dibrugeta | 1/2 | 3600 | 2 | |
| 80 | Tickell's thrush | *Turdus unicolor* | Auli | 3 | 2500 | 2 | + |
| 81 | Whitecollared blackbird | *Turdus albocinctus* | Belta Kharak | 3 | 2500-2800 | 1 | |
| 82 | Greywinged blackbird | *Turdus boulboul* | Auli | 3 | 2500 | 2 | + |
| 83 | Blackbird | *Turdus merula* | Belta Kharak, Auli | 3 | 2500-2800 | 2 | + |
| 84 | Mistle thrush | *Turdus viscivorus* | Dibrugeta | 2 | 3500 | 1 | |
| 85 | Wren | *Troglodytes troglodytes* | Deodi, Ramni | 6 | 3400-3700 | 2 | |
| 86 | Brown dipper | *Cinclus pallasi* | Kalikona to Doodganga, Dibrugeta, Base camp | 4 | 2600-3500<br>(5000) | 4 | |
| 87 | Alpine accentor | *Prunella collaris* | Pathalkhan | 5,1 | 4200 | 2 | |
| 88 | Robin accentor | *Prunella rubeculoides* | Sarsonpatal | 1 | 4200 | 1 | |
| 89 | Rufousbreasted accentor | *Prunella strophiata* | North Sanctuary | 2 | | | |

| No. | Species | | Locations | Habitat | Altitudes | Abundance ranking | Outside reserve |
|---|---|---|---|---|---|---|---|
| 90 | Greenbacked tit | *Parus monticolus* | Upto Chinwari, Auli | 3 | 2000-2700 | 4 | |
| 91 | Crested black tit | *Parus melanolophus* | Belta Kharak/Reni to Ramni, Bethartoli | 2,3 | 2000-3800 | 5 | |
| 92 | Black tit | *Parus rubidiventris* | Deodi, Trishul nallah-Rishiganga confluence | 2 | 3400-3700 | 2 | |
| 93 | Firecapped tit | *Cephalopyrus flammiceps* | Near Trishulnallah Rishiganga confluence, Joshimath | 2 | 3500, 1800 | 2 | |
| 94 | Whitethroated tit | *Aegithalos niveogularis* | Deodi, Dibrugeta | 2 | 3500-3700 | 2 | |
| 95 | Whitecheeked nuthatch | *Sitta leucopsis* | Dibrugeta | 2 | 3500 | 1 | |
| 96 | Tree creeper | *Certhia familiaris* | Dibrugeta | 1 | 3500 | 1 | |
| 97 | Himalayan tree creeper | *Certhia himalayana* | Dibrugeta, Deodi Trishul n.-Rishiganga confluence | 2 | 3300-3500 | 3 | |
| 98 | Indian tree pipit | *Anthus hodgsoni* | Dibrugeta - Deodi | 2/1 | 3300-3600 | 4 | |
| 99 | Vinaceousbreasted pipit | *Anthus roseatus* | Dibrugeta to Sarsonpatal | 1 | 3500-4500 | 5 | |
| 100 | Grey wagtail | *Motacilla caspica* | Rishiganga gorge | 4 | 2000-2800 | 2 | |
| 101 | Yellowbellied flowerpecker | *Dicaeum melanoxanthum* | Reni-Kalikona | 3 | 2300 | 1 | |
| 102 | White-eye | *Zostrepos palpebros* | Auli | 3 | 2500 | 3 | + |
| 103 | House sparrow | *Passer domesticus* | Around Joshimath | 7 | 2000 | - | + |
| 104 | Black-and-yellow grosbeak | *Mycerobas icterioides* | Auli | 3 | 2500-2700 | 2 | + |
| 105 | Spottedwinged grosbeak | *Mycerobas melanoxanthos* | Belta Kharak, Dibrugeta, Auli | 3,2 | 2800-3600 | 4 | |
| 106 | Goldfronted finch | *Serinus pusillus* | Around Joshimath | 7,3 | 2000 | 6 | + |
| 107 | Hodgson's mountain finch | *Leucosticte nemoricola* | North Sanctuary | 1 | 4000 | 2 | |
| 108 | Common rosefinch | *Carpodacus erythrinus* | Dibrugeta | 1 | 3600 | 1 | |
| 109 | Pinkbrowed rosefinch | *Carpodacus rhodochrous* | Dibrugeta, Pathalkhan | 2,6 | 3500-4100 | - | |
| 110 | Spottedwinged rosefinch | *Carpodacus rhodopeplus* | Deodi, North Sanctuary, Joshimath | 2,1,7 | 1900-4100 | - | |
| 111 | Whitebrowed rosefinch | *Carpodacus thura* | Dibrugeta | 2 | 3500 | - | |
| 112 | Beautiful rosefinch | *Carpodacus pulcherrimus* | Bethartoli | 6 | 4000 | 1 | |
| 113 | Redbreasted rosefinch | *Carpodacus puniceus* | Dibrugeta, Ramni Sarsonpatal, Joshimath | 2,1,7 | 1800-4200 | - | |
| 114 | Redheaded bullfinch | *Pyrrhula erythrocephala* | Near Ramni | 2 | 3600 | 2 | |

Key : Habitat
1 = Alpine meadow
2 = Sub-alpine forest
3 = Upper temperate forest
4 = water courses / bodies
5 = cliffs
6 = boulder strewn slopes with sparse vegetation
7 = Agriculture / habitation

Abundance ranking (based on sightings or calls heard)
1 = 1
2 = 2-5
3 = 6-10
4 = 11-50
5 = 50-100
6 = >100

Field guides : Ali *et al.* 1989
Fleming *et al.* 1976

# APPENDIX 3.

Bird species seen by Tak & Kumar (1987) and Reed (1979)
but not recorded during this expedition

| | | | Tak & Kumar 1987 | Reed 1979 | Casebolt 198* | Not in reserve |
|---|---|---|---|---|---|---|
| 1 | Geese | *Anser sp.* | | + | | |
| 2 | Black kite | *Milvus migrans* | | + | | + |
| 3 | Steppe eagle | *Aquila rapax* | + | + | | |
| 4 | Black eagle | *Ictinaetus malayensis* | | + | | |
| 5 | Cinereous vulture | *Aegypius monachus* | | + | | |
| 6 | Whitebacked vulture | *Gyps bengalensispy* | | + | | + |
| 7 | Egyptian vulture | *Neophron percnopterus* | + | + | | + |
| 8 | Peregrine falcon | *Falco peregrinus* | | + | | + |
| 9 | Tibetan snowcock | *Tetraogallus tibetanus* | | + | + | |
| 10 | Chukor partridge | *Aiectoris chukar* | + | | | |
| 11 | Kalij pheasant | *Lophura leucomelana* | | + | | |
| 12 | Woodcock | *Scolopax rusticola* | + | | | |
| 13 | Indian spotted dove | *Streptopelia chinensis* | + | | | |
| 14 | Pied crested cuckoo | *Clamator jacobrinus* | + | | | |
| 15 | Great horned owl | *Bubo bubo* | + | | | |
| 16 | Indian edible nest swiftlet | *Collacalia unicolor* | + | | | |
| 17 | Whiterumped spinetail swift | *Cheatura sylvatica* | + | | | |
| 18 | Honeyguide | *Indicator xanthonotus* | + | | | |
| 19 | Scalybellied green woodpecker | *Picus squamatus* | + | | | |
| 20 | Fulvousbreasted pied woodpecker | *Picoides macei* | | + | | + |
| 21 | Rufous short-toed lark | *Calendrella cinerea* | + | | | |
| 22 | Calandra lark | *Melanocorypha calandra* | | | + | |
| 23 | House martin | *Delichon urbica* | | + | | |
| 24 | Nepal house martin | *Delichon nipalensis* | + | | | |
| 25 | Tibet greybacked shrike | *Lanius tephronotus* | + | | + | |
| 26 | Golden oriole | *Oriolus oriolus* | | + | | + |
| 27 | Maroon oriole | *Oriolus trailli* | | + | | + |
| 28 | Grey drongo | *Dicrurus leucophasus* | + | | | |
| 29 | Spangled drongo | *Dicrurus hottentotus* | + | | | |
| 30 | Carrion crow | *Corvus corone* | | + | | |
| 31 | Raven | *Corvus corax* | | + | | + |
| 32 | Yellowthroated minivet | *Pericrocotus solaris* | | + | | + |
| 33 | Rosy minivet | *Pericrocotus roseus* | | + | | + |
| 34 | Striated babbler | *Turdoideds earlei* | | | + | + |
| 35 | Redheaded laughing thrush | *Garrulax erythrocephalus* | + | | | |
| 36 | Brown flycatcher | *Muscicapa latirostris* | | + | | |
| 37 | Rufousbreasted blue flycatcher | *Muscicapa hyperythra* | | | + | |
| 38 | Little pied flycatcher | *Muscicapa wetermanii* | | + | | + |
| 39 | Slaty blue flycatcher | *Muscicapa leucomelanura* | + | | | |
| 40 | Rufousbellied niltava | *Muscicapa sundara* | + | | + | |
| 41 | Verditer flycatcher | *Muscicapa thalassina* | + | | | |
| 42 | Whitethroated fantail flycatcher | *Rhipidura albicollis* | | + | | + |
| 43 | Spotted bush warbler | *Bradypterus thoracicus* | | | + | |
| 44 | Hume's bush warbler | *Cettia acanthizoides* | | | + | |
| 45 | Tickell's leaf warbler | *Phylloscopus affinis* | | + | + | |
| 46 | Smoky leaf warbler | *Phylloscopus fuligiventer* | | + | | |
| 47 | Orangebarred leaf warbler | *Phylloscopus pulcher* | | | + | |
| 48 | Yellowbellied warbler | *Abroscopus superciliaris* | | + | | + |
| 49 | Golden bush robin | *Erithacus chrsaeus* | | + | | |
| 50 | Whitefronted redstart | *Phoenicurus phoenicurus* | | | + | |
| 51 | Guldenstadt's redstart | *Phoenicurus erythrogaster* | | + | | |
| 52 | Hodgson's shortwing | *Hodgsonius phoenicuroides* | + | | | |
| 53 | Chestnutbellied rock thrush | *Monticola rufiventris* | | + | | + |
| 54 | Blue rock thrush | *Monticola solitarius* | + | + | | |
| 55 | Pied ground thrush | *Zoothera wardii* | + | | | |
| 56 | Blackthroated accentor | *Prunella atrogularis* | | + | | + |
| 57 | Maroonbacked accentor | *Prunella immaculata* | | + | | + |
| 58 | Grey tit | *Parus major* | + | | | |
| 59 | Brown crested tit | *Parus dichrous* | + | | + | |

| | | | Tak & Kumar 1987 | Reed 1979 | Casebolt 198* | Not in reserve |
|---|---|---|---|---|---|---|
| 60 | Yellowbrowed tit | *Sylviparus modestus* | | + | | + |
| 61 | Brown tit-mouse | ? | | | + | |
| 62 | Red headed tit | *Aegithalos concinnus* | + | | ? | |
| 63 | Wall creeper | *Tichodroma muraria* | | + | | |
| 64 | Upland pipit | *Anthus sylvanus* | | + | | |
| 65 | Pied wagtail | *Motacilla alba* | | + | | |
| 66 | Allied grosbeak | *Mycerobas affinis* | + | + | | + |
| 67 | Whitewinged grosbeak | *Mycerobas carnipes* | | + | | |
| 68 | Himalayan goldfinch | *Carduelis spinoides* | | + | | + |
| 69 | Tibetan twite | *Acanthis flavirostris* | | + | | |
| 70 | Himalayan mountain finch | *Leucosticte brandti* | | | + | |
| 71 | Nepal rosefinch | *Carpodacus nipalensis* | | + | | |
| 72 | Eastern great rosefinch | *Carpodacus rubicolloides* | | + | | |
| 73 | Redheaded rosefinch | *Propyrrhula subhimachala* | | + | | |
| 74 | Orange bullfinch | *Pyrrhula aurantiaca* | + | | | |
| 75 | Pine bunting | *Emberiza leucocephala* | + | | | |
| 76 | Rock bunting | *Emberiza cia* | | + | | |
| 77 | Greyheaded bunting | *Emberiza fucata* | | + | | + |
| 78 | Crested bunting | *Melophus lathami‘* | | + | | |

# THE BUTTERFLIES OF NANDADEVI

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## INTRODUCTION

The Nanda Devi area was declared as a National Park on 06 November 1982 and later as a Biosphere Reserve on 18 January 1988. Studies on the fauna of Nanda Devi National Park are few and deal mainly with mammals and birds. There is an absence of systematic surveys or studies on the invertebrate fauna. The Zoological Survey of India is preparing a detailed report on the invertebrates but it may take some more time before it is published (Dr G.S.Arora,pers comn). The Corps of Engineers Scientific and Ecological Expedition to Nanda Devi (7817m) 1993 of the Indian Army carried out the first scientific studies on flora and fauna since the ZSI/BSI surveys of early eighties. A small group of scientists of the fields of Ornithology, Mammology, Botany and Environmental science carried out survey of the National Park in May-June 1993. The author was the Officer -in-charge Ecology on behalf of the Army. The author has attempted to remedy the lack of entomological activity by carrying out studies on the butterfly fauna of Nanda Devi. The study was carried out in the form of survey, relative abundance studies using circular plots and observation of behaviour of important butterfly species.

## OBJECTIVES

The aim of the study was threefold viz:-

(a) To record the species of butterflies occurring in Nanda Devi National Park and Biosphere Reserve.

(b) To study the distribution and relative abundance of butterflies.

(c) To identify preferred host and nectar plants of butterflies and their larvae.

## METHODS

To fulfil the above mentioned objectives the following methods were used.

Recording of species.

Butterflies seen during moves and halts were observed. Identification was done using Wynter-Blyth(1957),Evans (1932) and Mani(1986). Most butterflies were netted, identified and released. No specimen was taken within the boundaries of the Nanda Devi National Park. A few specimens of butterflies which could not be identified, such as Lycaenids, were collected outside the National Park in the buffer zone of the Biosphere Reserve. Any dead butterflies and wings which were found were also collected.These were identified by Dr G.S. Arora and the specimens were deposited in the Northern Regional Station of the ZSI.

### Distribution and Relative Abundance.

Circular plot method was used to record data regarding butterfly abundance. A total of 24 sample plots were taken at eight locations. Each plot was for a duration of 20 minutes. Minimum weather conditions were laid down, viz the plot had to have sunshine for a duration of at least 15 minutes. Each butterfly was identified and its name, direction, distance and time were noted down. Full attempt was made to ensure that double counting did not take place.

### Study of Host and Nectar Plants.

Observations were made on the plants frequently utilized by butterflies. Listing of nectar resources was done. Important perching preferences were noted. Female butterflies of various species were followed and closely observed to record those plants that they laid eggs on. Besides this observations were also made on aspects of behaviour such as flight pattern and mating.

## RESULTS AND DISCUSSION

The expedition was in the Nanda Devi area during May and June. In the higher reaches ie 3000m and above, the spring is short in duration and comes late. The lateness and reduction in duration increases the higher one goes. This has an influence on the phenology and ecology of plants as well as the butterfly fauna utilizing them. Thus we were early and able to record only 27 species of butterflies during the entire trip. The composition and relative abundance of the butterflies changed as time passed. In addition, egglaying activities were observed in three species only, all of which had been flying from the time of our entry into the National Park.

### Species seen

Twenty seven species were recorded during the study. These are listed in Table 1. The family-wise representation is as follows :-

(a) Papilionidae - 2 species.

(b) Pieridae - 9 species.

(c) Satyridae -2 species.

(d) Nymphalidae - 9 species.

(e) Lycaenidae - 4 species.

(f) Libytheidae - 1 species.

No Danaids or Hesperiids were noticed. Of the 27 species recorded, three species were seen on the way in only, 13 species were seen throughout and 11 species were seen on the way out only ie after 10 June 1993. This has been indicated in Table 1 also. Here status based on the system used by Haribal et al in Butterflies of Sikkim (1988) has also been given.

## Distribution and Relative Abundance

Circular plots were used in preference to transects due to unfamiliar and rugged nature of terrain.A total of 24 plots were taken at eight locations. Of these 11 plots were taken at Sarson Patal and seven at Dibrughetta. One plot was taken at each of the other locations.The number of plots were found to be inadequate hence no statistical analysis has been attempted. The composition of butterfly fauna noted during the plots is given in Table 2. The composition of buterflies at all study sites is given in Table 3.

### Sarson Patal

Sarson Patal is a high altitude alpine meadow eight kms long and about one km wide, having aspect of North-East and general slope of 30-40°. It ranges between 4200m and 4500m. The meadow has some scree slopes,some marsh,many streams as well as dense stands of shrubs such as *Juniperus, Rhododendron anthopogon, Cassiope* and various species of *Salix*.

During the study the major butterflies species were Common Yellow Swallowtail *Papilio machaon*, Common Blue Apollo *Parnassius hardwickei*, Dark Clouded Yellow *Colias electo*, Queen of Spain *Issoria lathonia* and Indian Tortoiseshell *Aglais cashmirensis*. Also three specimens of Lofty Bath White *Pontia callidice* were seen flying after first week of June.

Common Blue Apollo preferred grassy meadow and was rarely seen on scree,marsh, *Cotoneaster* or *Juniper*. It was seen wherever *Saxifraga* or *Dantonia* was predominant. Dark Clouded Yellow was more widespread but preffered flowering meadow.It was scarce on grassy meadows and absent from scree.

The Common Yellow Swallowtail was scarce on grassy meadows and generally flew on slopes protected from wind and having *Juniperus* or having abundant flowers.

The Queen of Spain was the least common of the major species. It was encountered on slopes having abundant flowers or *Rhododendron-Cassiope-Salix* association.

The Indian Tortoiseshell was scarce on meadow and frequented scree,stream banks and Juniperus slopes. Generally butterfly density decreased as one moved higher up the meadow.Diversity and density was higher in the pockets of marsh and stands of flowers, *Juniperus*, or *Rhododendron-Salix* association.Scree slopes had poorest butterfly fauna.

### Dibrughetta

This is an alpine meadow from 3600m to 3800m and is 800m long and 150m wide.It is flanked by *Betula-Abies spectabilis* forest on both sides.Plots were taken at 3600m,3650m and 3700m. The major species were Common Yellow Swallowtail , Dark Clouded Yellow and Indian Tortoiseshell. Dark Clouded Yellow was abundant throughout the meadow.Indian Tortoiseshell was commoner on the upper slopes.Common Yellow Swallowtail was found all over the meadow but was scarce everywhere.Queen of Spain was common at Malla Dibrughetta (4000m) but became scantier as one descended lower to Dibrughetta.During the move inwards only one Small Copper *Lycaena phleas* was seen. During the return this butterfly was abundant at Dibrughetta.

### Moraine

This was moraine with few flowering herbs such as *Androsace* and *Saxifraga*. The Indian Tortoiseshell was scanty on the lower glacier and increasing till it was abundant at the upper glacier region.One Common Blue Apollo was seen on the lower glacier and ten Lofty Bath White were seen on the lower and middle glacier.Above 17000' the vegetation ended but Indian Tortoiseshell continued to be seen till Camp 3 approx 22,700' where it was captured on video tape by Maj B.V.Naresh.This may be an altitudinal record for the butterfly.

### Rishiganga Valley

This has mixed coniferous/temperate forest along it with *Betula* on the higher reaches.Hardly any butterflies were evident during the entry. Most of the butterflies seen were recorded at Rini at the end of the expedition.

### Deodi

Mostly *Betula* forest with a few open patches.Notable was sighting of a single Large Tortoiseshell *Aglais xanthomelos.*

### Ramani

Small strip of *Betula* forest on Rishi bank.Plot was taken opposite the camp on Bagni hill at 3800m. The notable find was a single Eastern Comma *Vanessa egea* at lower edge of *Rhododendron* forest at approx 3600m.

### Dharansi

High altitude pass at 4200m.Composition of butterflies is similar to that of Sarson Patal. At Satkula small white butterflies flying rapidly but well out of reach were seen.These could possibly be a *Baltia* species.Common Blue Apollo was also seen at this location.

### Lata Kharak

High altitude abandoned cattle camp at 3800m.Adjacent to *Betula-Rhododendron* forest.Has good floral diversity but with considerable presence of *Rumex* and *Polygonum.* Here composition of species is similar to that of Dibrughetta on the other side of this range.

### Belta Kharak

Small clearing on Belta nala at 3600m amidst sub-temperate coniferous/mixed forest.*Rumex* and rocks predominate in the undergrowth.Here large numbers of Indian Cabbage White *Artogeia canidia,* Large Cabbage White *Pieris brassicae* and Indian Tortoiseshell were seen.

### Lata village

It lies 200m above the Mallari road and consists of cultivation interspersed with mixed scrub jungle.Plot was taken at the upper water point of the village. The day was sunny and butterflies such as Large Silverstripe *Childrena childreni,* Great Black-vein *Aporia agathon* and Beak *Libythea* spp were recorded from here.

## Nectar resources and Host plants

High altitude butterflies are short lived and may fly more than one brood in the short spring and summer. There is a distinct succession in alpine flora and the phenology of various plants. This would make resources available for some species and not others. The different broods of species also would encounter a flora of different composition and state of growth depending upon their time of emergence. Besides this butterflies having wide geographical and altitudinal distribution per force have to utilise more than one host plant. For these reasons data was collected on nectar resources and food plants. These are tabulated in Table 4. Dark Clouded Yellow and Indian Tortoiseshell are seen to be generalists having been recorded on ten and eight plant species respectively. Queen of Spain is more selective having been seen on Gentians always except once. Common Blue Apollo was noticed on *Saxifraga* and *Primula* only. At Rini (6500') *Cirsium walliichi*, a roadside weed, was seen attracting large numbers of butterflies of various species.

Female butterflies of various species were followed for various durations in order to observe their egglaying behaviour. Host plants of three species could be identified. These are :-

(a) Common Yellow Swallowtail was observed laying single eggs on tips and underside of leaves of *Cortia depressa* an umbelliferous herb at Sarson Patal on 07 Jun 93.

(b) Queen of Spain was seen to lay single eggs on underside of very young plant of *Potentilla fruticosa* (Rosaceae) at Sarson Patal on 12 Jun 93.

(c) Dark Clouded Yellow was seen to lay single eggs on underside of leaf of a young plant of *Hedysarum kumaonense* (Papilionaceae) at Sarson Patal on 12Jun 93.

## Conclusion

Several interesting questions have arisen with the completion of this short study of the butterflies of Nanda Devi. When do the butterflies of Sarson Patal and lower heights emerge? How many broods do they fly? Which are the nectar resources used and how are they used in different seasons altiudes and locations? Do they carry out any local migrations? The endless questions which arise serve to highlight the fact that we know pitifully little about these beautiful insects of which India has such a splendid diversity. Only once such questions are answered can we devise effective conservation measures for those butterflies whose habitats are threatened and numbers are perilously low.

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## TABLE 1:LIST OF BUTTERFLIES OCCURRING IN NANDADEVI NATIONAL PARK AND BIOSPHERE RESERVE

| S. No | Scientific Name | Common Name | Status | Remarks |
|---|---|---|---|---|
| Family Papilionidae | | | | |
| 1 | Papilio machaon | Common Yellow Swallowtail | VC | BOTH |
| 2 | Parnassius hardwickei | Common Blue Apollo | LC | BOTH |
| Family Pieridae | | | | |
| 3 | Artogeia canidia | Indian Cabbage White | VC | BOTH |
| 4 | Pieris brassicae | Large Cabbage White | C | OUT |
| 5 | Pontia daplidice | Bath White | NC | OUT |
| 6 | Pontia callidice | Lofty Bath White | LC | BOTH |
| 7 | Aporia agathon | Great Blackvein | LC | OUT |
| 8 | Aporia leucodice | Himalayan Blackvein | LC | OUT |
| 9 | Delias belladonna | Hill Jezebel | S | IN |
| 10 | Colias electo | Dark Clouded Yellow | VC | BOTH |
| 11 | Catopsilia sp | Emigrant | C | OUT |
| Family Satyridae | | | | |
| 12 | Erebia nirmala | Common Argus | NC | OUT |
| 13 | Pararge sp | Wall | S | BOTH |
| Family Nymphalidae | | | | |
| 14 | Neptis mahendra | Himalayan Sailer | NC | OUT |
| 15 | Cynthia cardui | Painted Lady | NC | BOTH |
| 16 | Vanessa indica | Indian Red Admiral | S | OUT |
| 17 | Vanessa egea | Eastern Comma | S | IN |
| 18 | Aglais cashmirensis | Indian Tortoiseshell | VC | BOTH |
| 19 | Aglais xanthomelos | Large Tortoiseshell | S | IN |
| 20 | Childrena childreni | Large Silverstripe | NC | OUT |
| 21 | Childrena kamala | Common Silverstripe | NC | OUT |
| 22 | Issoria lathonia | Queen of Spain | VC | BOTH |
| Family Libytheidae | | | | |
| 23 | Libythea sp | Beak | S | OUT |
| Family Lycaenidae | | | | |
| 24 | Lycaena phleas | Small Copper | C | BOTH |
| 25 | Lycaena pavana | White-bordered Copper | NC | BOTH |
| 26 | Celastrina huegelii | Large Hedge Blue | VC | BOTH |
| 27 | Lampides boeticus | Peablue | C | BOTH |

Note: Status is as per notations given by Haribal et al ,Butterflies of Sikkim 1987. This is given below :
VC - Very Common More than 20 specimens seen.
C - Common Upto 20 specimens seen.
NC - Not Common Upto 10 specimens seen.
LC - Locally Common More than five specimens seen only at a particular place.
S - Single or two specimens encountered.

Also butterflies encountered in the way in only are remarked as IN,those that were seen on the way out only are remarked as OUT and those that were seen both during entry and exit are remarked BOTH.

## TABLE 2:DISTRIBUTION OF BUTTERFLIES IN NANDADEVI NATIONAL PARK AND BIOSPHERE RESERVE

| Ser No | Scientific Name | RISHI GANGA | LATA VILLAGE | BELTA KHADAK | DEODI | RAMNI & BAGNI | DIBRU GHETTA | LATA KHADAK | DHARANSI | SARSON PATAL | MORAINE & MOUNTAIN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Altitude (m)** | | **2150 -2600** | **2400** | **3200** | **3200** | **3400-3600** | **3600** | **3800** | **4200** | **4200-4500** | **4600-7800** |
| 1 | Papilio machaon | + | + | + | + | + | + | + | + | + | - |
| 2 | Parnassius hardwickei | - | - | - | - | - | - | - | + | + | + |
| 3 | Artogeia canidia | + | + | + | + | - | + | - | - | - | - |
| 4 | Pieris brassicae | + | + | + | - | - | + | + | - | + | - |
| 5 | Pontia daplidice | + | - | - | - | - | - | - | - | - | - |
| 6 | Pontia callidice | - | - | - | - | - | - | - | - | - | - |
| 7 | Aporia agathon | - | + | - | - | - | - | - | - | - | - |
| 8 | Aporia leucodice | + | + | - | - | - | - | - | - | - | - |
| 9 | Delias belladonna | + | - | - | - | - | - | - | - | - | - |
| 10 | Colias electo | + | + | + | + | + | + | + | + | + | + |
| 11 | Catopsilia spp | + | + | + | - | - | - | - | - | - | - |
| 12 | Erebia nirmala | + | + | - | - | - | - | - | - | - | - |
| 13 | Pararge spp | + | + | - | - | - | - | - | - | - | - |
| 14 | Neptis mahendra | + | + | + | - | - | - | - | - | - | - |
| 15 | Cynthia cardui | - | - | - | - | - | + | + | - | - | - |
| 16 | Vanessa indica | - | + | + | - | - | - | - | - | - | - |
| 17 | Vanessa egea | - | - | - | - | + | - | - | - | - | - |
| 18 | Aglais cashmirensis | + | + | + | + | + | + | + | + | + | + |
| 19 | Aglais xanthomelos | - | - | - | + | - | - | - | - | - | - |
| 20 | Childrena childreni | - | + | + | - | - | - | - | - | - | - |
| 21 | Childrena kamala | - | - | + | - | - | - | - | - | - | - |
| 22 | Issoria lathonia | - | + | + | + | - | + | + | + | + | - |
| 23 | Libythea spp | - | + | - | - | - | - | - | - | - | - |
| 24 | Lycaena phleas | + | + | + | - | - | + | + | - | - | - |
| 25 | Lycaena pavana | + | - | - | - | - | - | - | - | - | - |
| 26 | Celastrina huegelii | - | + | + | - | - | - | - | - | - | - |
| 27 | Lampides boeticus | - | + | + | - | - | - | - | - | - | - |
| TOTAL NO OF SPECIES | | 14 | 18 | 14 | 6 | 4 | 8 | 7 | 5 | 7 | 3 |

# TABLE 3:RELATIVE ABUNDANCE OF BUTTERFLIES IN NANDADEVI NATIONAL PARK AND BIOSPHERE RESERVE

| Ser No | Scientific Name | LATA VILLAGE | | BELTA KHADAK | | DEODI | | RAMNI & BAGNI | | DIBRU GHETTA | | LATA KHADAK | | SARSON PATAL | | MORAINE/ MOUNTAIN | | GRAND TOTAL | OVERALL % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Altitude (m) | 2400 | | 3200 | | 3200 | | 3400-3600 | | 3600 | | 3800 | | 4200-4500 | | 4600-7800 | | | |
| | | | % | | % | | % | | % | | % | | % | | % | | % | | |
| 1 | Papilio machaon | - | | 1 | 1.64 | - | | - | | 17 | 13.18 | 4 | 18.18 | 23 | 10.70 | - | | 45 | 8.46 |
| 2 | Parnassius hardwickei | - | | - | | - | | - | | - | | - | | 83 | 38.60 | - | | 83 | 15.60 |
| 3 | Artogeia canidia | 19 | 31.67 | 11 | 18.03 | - | | - | | 1 | 0.78 | - | | - | | - | | 31 | 5.83 |
| 4 | Pieris brassicae | 1 | 1.67 | 14 | 22.95 | - | | - | | - | | - | | 1 | 0.47 | - | | 16 | 3.01 |
| 5 | Po..ia callidice | - | | - | | - | | - | | - | | - | | 2 | 0.93 | - | | 2 | 0.38 |
| 6 | Aporia agathon | 4 | 6.67 | - | | - | | - | | - | | - | | - | | - | | 4 | 0.75 |
| 7 | Colias electo | 1 | 1.67 | 6 | 9.84 | 3 | 50.00 | 18 | 85.71 | 88 | 68.22 | 5 | 22.73 | 68 | 31.63 | - | | 189 | 35.53 |
| 8 | Catopsilia spp | 6 | 10.00 | 1 | 1.64 | - | | - | | - | | - | | - | | - | | 7 | 1.32 |
| 9 | Erebia nirmala | 1 | 1.67 | - | | - | | - | | - | | - | | - | | - | | 1 | 0.19 |
| 10 | Neptis mahendra | 1 | 1.67 | 4 | 6.56 | - | | - | | - | | - | | - | | - | | 5 | 0.94 |
| 11 | Cynthia cardui | - | | - | | - | | - | | 2 | 1.55 | - | | - | | - | | 2 | 0.38 |
| 12 | Vanessa indica | 1 | 1.67 | - | | - | | - | | - | | - | | - | | - | | 1 | 0.19 |
| 13 | Aglais cashmirensis | 9 | 15.00 | 12 | 19.67 | - | | 3 | 2.33 | 15 | 11.63 | 11 | 50.00 | 23 | 10.70 | 18 | 100.0 | 91 | 17.11 |
| 14 | Aglais xanthomelos | - | | - | | 1 | 16.67 | - | | - | | - | | - | | - | | 1 | 0.19 |
| 15 | Childrena childreni | - | | 3 | 4.92 | - | | - | | - | | - | | - | | - | | 3 | 0.56 |
| 16 | Issoria lathonia | - | | 1 | 1.64 | 2 | 33.33 | - | | 3 | 2.33 | 1 | 4.55 | 15 | 6.98 | - | | 22 | 4.14 |
| 17 | Libythea spp | 1 | 1.67 | - | | - | | - | | - | | - | | - | | - | | 1 | 0.19 |
| 18 | Lycaena phleas | 1 | 1.67 | - | | | | - | | 3 | 2.33 | - | | - | | - | | 4 | 0.75 |
| 19 | Unidentified Lycaenids | 15 | 25.00 | 8 | 13.11 | - | | - | | - | - | 1 | 4.55 | - | | - | | 24 | 4.51 |
| | **TOTAL NO OF BUTTERFLIES** | **60** | | **61** | | **6** | | **21** | | **129** | | **22** | | **215** | | **18** | | **532** | |

## TABLE 4: UTILISATION OF NECTAR RESOURCES BY BUTTERFLIES OF NANDADEVI

| S. No | Butterfly species | Nectar Resource | Place | Date |
|---|---|---|---|---|
| 1 | Common Yellow Swallowtail | Primula denticulata | Sarson Patal | 10Jun93 |
| | Papilio machaon | Arnebia benthamii | Dharansi | 17Jun93 |
| | | Androsace Sarmentosa | Lata Khadak | 20Jun93 |
| 2 | Indian Tortoiseshell | Saxifraga hemispherica | Moraine | 06Jun93 |
| | Aglais Cashmirensis | Primula denticulata | Sarson Patal | 10Jun93 |
| | | Potentilla argyrophylla | Patal Khan | 12Jun93 |
| | | Rhododendron anthopogon | Patal Khan | 12Jun93 |
| | | Berginia stracheyi | Patal Khan | 12Jun93 |
| | | Rhodiola heterodonta | Patal Khan | 12Jun93 |
| | | Cotoneaster microphyllus | Dibrughetta | 16Jun93 |
| | | Thymus serpyllum | Belta Khadak | 20Jun93 |
| 3 | Common Blue Apollo | Saxifraga pulvinaria | Sarson Patal | 30May93 |
| | Parnassius hardwickei | Primula denticulata | Sarson Patal | 01Jun93 |
| | | Primula minutissima | Sarson Patal | 01Jun93 |
| 4 | Dark Clouded Yellow | Primula minutissima | Sarson Patal | 01Jun93 |
| | Colias electo | Salix karelini | Sarson Patal | 04Jun93 |
| | | Primula denticulata | Sarson Patal | 10Jun93 |
| | | Lloydia serotina | Sarson Patal | 10Jun93 |
| | | Potentilla argyrophylla | Sarson Patal | 10Jun93 |
| | | Lonicera spinulosa | Sarson Patal | 10Jun93 |
| | | Nomocharis oxypetala | Dibrughetta | 16Jun93 |
| | | Taraxacum officinale | Dibrughetta | 16Jun93 |
| | | Potentilla atrosanguinea | Lata Khadak | 20Jun93 |
| | | Rhodiola heterodonta | Lata Khadak | 20Jun93 |
| 5 | Queen of Spain | Lonicera spinulosa | Sarson Patal | 08Jun93 |
| | Issoria lathonia | Gentiana carinata | Dibrughetta | 16Jun93 |
| | | Gentiana argentia | Dharansi | 17Jun93 |
| 6 | Bath White | Cirsium walliichi | Rini | 22Jun93 |
| | Pontia daplidice | | | |
| 7 | Indian Cabbage White | Nomocharis oxypetala | Belta Khadak | 20Jun93 |
| | Artogeia canidia | Thymus serpyllum | Belta Khadak | 20Jun93 |
| | | Cirsium walliichi | Rini | 22Jun93 |
| 8 | Large Cabbage White | Anemone obtusifolia | Dibrughetta | 16Jun93 |
| | Pieris brassicae | Rhodiola heterodonta | Lata Khadak | 20Jun93 |
| 9 | Hill Jezebel | Viburnum cotonifolium | Murrunda | 08May93 |
| | Delias belladonna | | | |
| 10 | Small Copper | Geum roylei | Dibrughetta | 16Jun93 |
| | Lycaena phleas | | | |
| 11 | White-bordered Copper | Cirsium walliichi | Rini | 22Jun93 |
| | Lycaena pavana | | | |

# CONSERVATION STATUS OF FORESTS IN THE BUFFER ZONE.

AJAY RASTOGI
WORLD WIDE FUND FOR NATURE INDIA

## INTRODUCTION

On the assumption that the sources of disturbance to the forests in the buffer zone were all anthropogenic it was considered logical to assess the status of forests adjoining the villages.

## OBJECTIVE

To assess the status of forests adjoining villages of the buffer zone.

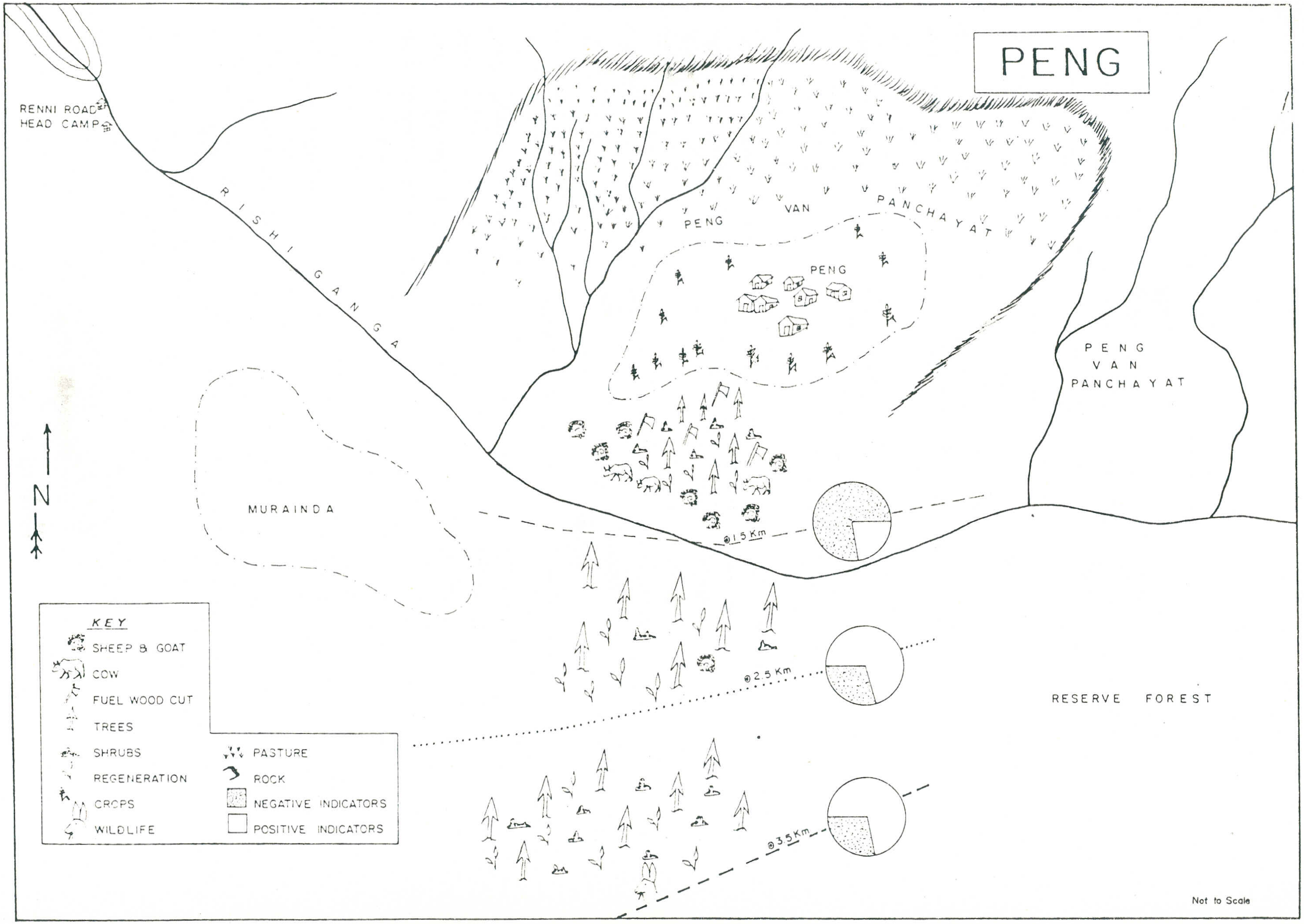
## METHODS

Four villages out of a total of ten located in the buffer zone within Garhwal region, were selected based on certain considerations such as seasonal use/round the year use, availability/non availability of Van Panchayat forests and number of directions in which the forests occur from a village etc. This was important in order to get a balanced picture within the short span of four weeks that were available for the study.

To quantify the status of forest around the selected villages. a modified point intercept method (Mullar-Dumbois, D. & Ellenberg, H. 1974. Aims and methods in vegetation ecology. John Wiley and Sons, New York) was used to record data. Data was collected along the path used by the villagers to go to the forest. After every 15 minutes of walk along the path I walked in any randomly selected direction into the forest. The position of the toe at every tenth step was taken as a reference as a point. Within a one meter radius of this point data was collected both on positive as well as negative indicators to assess the status of the forests. Negative indicators are fuelwood cutting, wood cutting for other purposes, lopping for fodder, grazing by domestic livestock and occurrence of human path/trail within the forest. Positive indicators include regeneration, availability of useable fallen wood and signs of wildlife. This information has been presented on the frequency of occurrence (f.o.) basis. Besides this, occurrence of tree and shrub species were recorded at every sampling point. This has been expressed on percentage of occurrence (p.o.) basis. The above data was collected at 10 points at every location.

Time was taken to be the unit of distance from the village because for all practical purposes the amount of effort involved in any such activity such as bringing the head load of wood or taking the livestock for grazing by a villager is measured in time. Especially in mountain areas walking up a steep slope on a hill involves a lot of effort and time even for covering small distances. So a villager shows preference for gradual slopes and for walking down the slopes after collection even if the distance is greater.

To gather relevant socio-economic information and draw maps of the village and adjoining forest Participatory Rural Appraisal (PRA) techniques (Gibbs & Christopher 1987. Rapid Rural Appraisal: an overview of concepts and applications. In proceedings of the 1985 International Conference on Rapid Rural Appraisal, University of Khou Kaen, Thailand) were used.


PENG
RENNI ROAD HEAD CAMP
RISHI GANGA
PENG VAN PANCHAYAT
PENG
PENG VAN PANCHAYAT
MURAINDA
@1.5 Km
@2.5 Km
@3.5 Km
RESERVE FOREST
N
KEY
SHEEP & GOAT
COW
FUEL WOOD CUT
TREES
SHRUBS
REGENERATION
CROPS
WILDLIFE
PASTURE
ROCK
NEGATIVE INDICATORS
POSITIVE INDICATORS
Not to Scale

## PROFILE OF PENG

| | |
|---|---|
| Altitude | 2500 m |
| Total number of households | 30 |
| Average family size | 5 |
| Average land holding per family (10 Nalis = approx. 1 Acre) | 15 Nalis |
| Average production of main crops (kg/nali) | |
| Potato *Solanam tuberosum* | 100 |
| Amaranth *Amaranthus paniculatus* | 9 |
| Phaphar *Fagopyrum tataricum* | 12 |
| Wheat *Tritucum aestivum* | 15 |
| Cheema *Panicum milliaceum* | 8 |
| Garlic *Allium* sp. | 6 |
| Ogal *Fagopyrum esculentum* | 8 |
| Average crop damage by wildlife | 10% |

Domestic livestock

| Bulls | Total cows | Milch cows | Jersey cows | Goats | Sheep | Horses | Total livestock |
|---|---|---|---|---|---|---|---|
| 45 | 75 | 23 | 0 | 80 | 300 | 0 | 523 |

| | |
|---|---|
| Domestic livestock killed by leopard in last five years | None |
| School in the village | Primary school |

Average level of literacy in the current generation

| Females | Males |
|---|---|
| Junior High School (Class VIII) | High School (Class X) |

| | |
|---|---|
| No of graduates in the village | No information |
| No. of persons employed outside | No information |
| Health services | Hospital at Joshimath (23 km away) |
| Distance from motorable road | 4 kms |

## RESULTS & DISCUSSIONS

The reseults of the survey are presented as case studies of each village.

### PENG

Peng has a comparatively smaller Van Panchayat area which is very steep and rocky. Therefore, it is largely utilised for livestock grazing. The most extensive patch of forests lie to the south of the village; across the Rishi Ganga River. A permanent wooden bridge below the village on the Rishi Ganga facilitates the movement of the people of Peng to this area round the year.

It is a twenty minute walk down hill, through a *Cupressus, torulosa* forest, to the Rishi Ganga river. The other associate species are: *Indigogera, heterantha, Rhamnus virgatus, Desmodium elegans* and *Skimmia laureola;* percentage occurrence (p.o.) of each being 10%.

The negative indicators are evenly spread in high intensities in this small patch of evergreen forest. The livestock signs were observed on all the points and the human path criss crosses the transect all over, f.o. for fuel wood cutting intensity was 4. Lopping pressure was however found to be absent in the absence of any fodder species. The composite value for the negative indicators was three times more than that of the positive ones.

Forests across the Rishi Ganga are in much finer shape. This large tract of mixed forests comprises of *Abies pindrow* (p.o 30%), *Litsea umbrosa* (p.o.30%) *and Toona serrata* (p.o. 10%) as tree cover. The shrub cover mainly comprises of bamboo *(Arundinarea, falcata)* along with *Desmodium elegans* and *Berberis, lycium* in low densities. (For local names of the plant species refer Appendix 1)

There were no signs of lopping and fuel wood cutting. Collection of bamboo and signs of livestock grazing were restricted to just one observation. There was little useable fallen wood lying on the forest floor and no sign of any wild animal observed. The frequency of occurrence of young seedlings/saplings both in tree species, and bamboo together was six out of every ten points, which indicates sufficient regeneration is taking place. There was a complete change in the composite negative/positive indicator values, with the composite value for positive indicators some what higher than the negative ones.

The third set of observations were recorded after a walk of 45 minutes from Peng after having covered a distance of about two km up the steep slope south of the Rishi Ganga. The forest here is more diverse. Tree cover comprises of mainly *Celtis australis* (p.o.20%), *Juglans regia* (p.o. 10%) *and the shrubs are Desmodium elegans* (p.o.30%) *Arundinaria flcata* (p.o. 20%) *Rosa sericea* (p.o.20%), *Artemisia nilagirica* (p.o.10%), *Deutzia staminea* (p.o 10%) *and Spiraea arcuta* (p.o.10%). Other than signs of lopping (f.o.2) and human trail once in the whole transect no other negative indicator was present here. Low regeneration was observed due to the thick undergrowth of shrubs. Almost all useable fallen wood was lying on the forest floor and wildlife signs were present. Within the transect Goral *(Naemorhaedus goral)* was sighted once and outside the transect in the same forest patch fresh scat of Black bear *(Selenarctos thibetanus)* and an old scat of the Common leopard *(Panthera pardus)* were observed.

Further north west about 1.5 km to this area lies Murainda Village but there is no impact from that side too. This is primarily because Murainda has some forest to the north and extensive forests in the other three directions. The only factor which is likely to cause an impact on the conservation values of this area is the extension of the activities of the U.P.Forest Corporation. They have already reached within two kilometers of this area in their operation involving extraction of dead and decaying wood. The forest corporation under the strict vigilance of the Nanda Devi Biosphere Reserve Staff is not cutting any green tree. However, the fact remains that in a wildlife reserve even dead and decaying wood plays crucial role in the life of many animals such as amphibians., reptiles, birds, insects etc.

From the historical perspective this forest area, falling under beat number seven of Dunagiri block in Joshimath Range, is precisely the location where the 'Chipko Movement' was started. The late Srimati Gaura Devi, who pioneered this idea and mobilised the folks from the neighbouring villages hailed from Reni Village located approximately 4 km further west of this location. Mr.Chandi Prasad Bhatt, the leader who brought the Chipko Movement in prominence; views this operation of the forest corporation as one of the most dangerous factors for future degradation of this area. He also expressed that the sentiments of the conservation conscious people of Lata, Reni, Peng, Murainda and others had been badly hurt and that this may progressively lead to change in their attitude towards the forest which they so far had considered to be their own and had therefore afforded protection. So this activity which on the face of it appears quite harmless could have long term adverse consequences on the overall conservation values of this area. Mr.Bhatt emphasised the need for the immediate withdrawal of the U.P. Forest Corporation from the area.

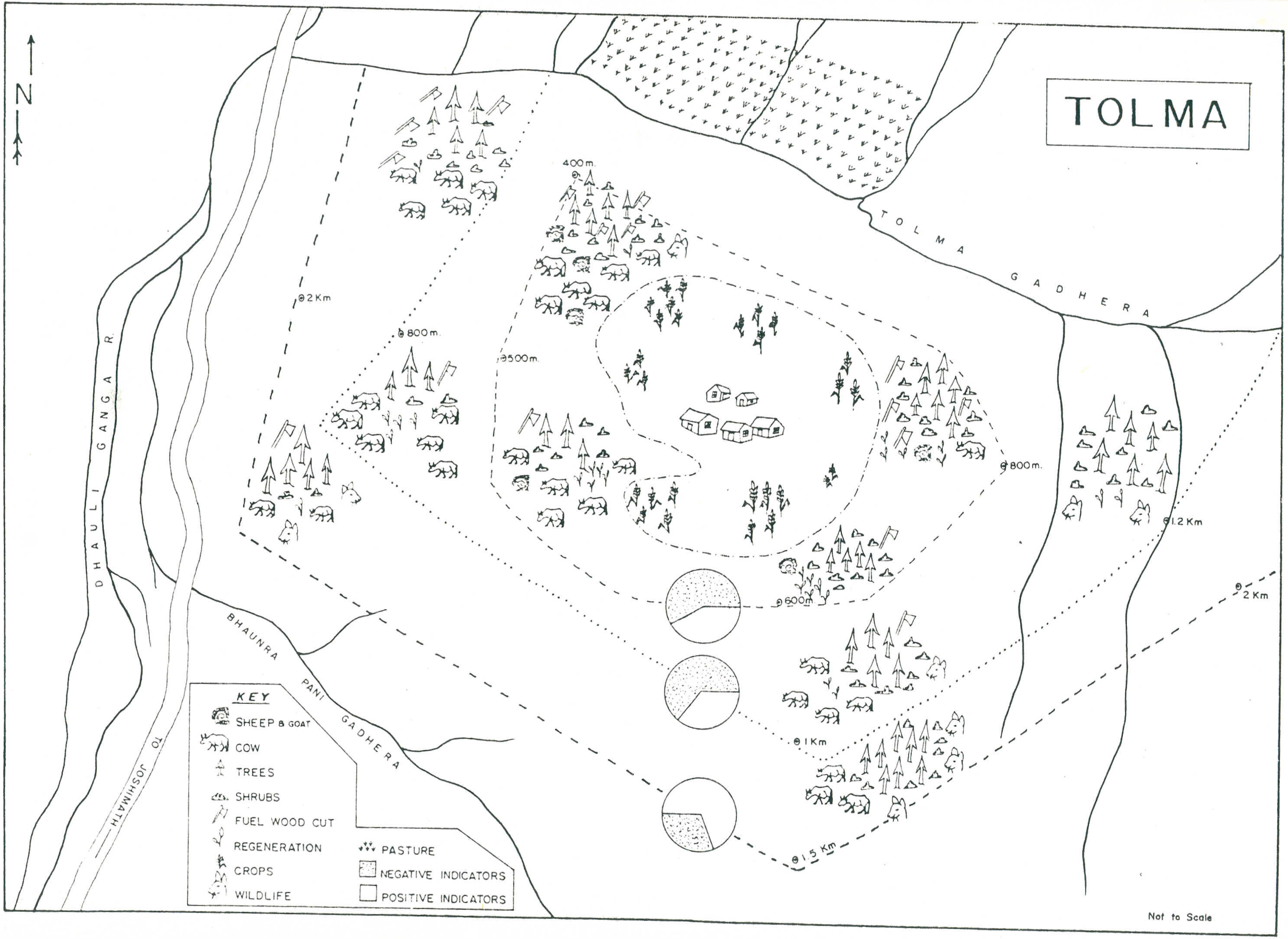
## TOLMA

The residents of Tolma shift to Gurma Gwad in severe winter months, from November to February. Thus the forests around Tolma are used for about eight months in a year. Van Panchayat forests of Tolma cover an area of 4450 hectares and are extensively spread out on all sides of the village except in the north where Tolma nallah forms a natural barrier.

Tolma's Van Panchayat forests are predominantly of Deodar *(Cedrus deodara)* and Blue Pine *(Pinus wallichiana)* in the vicinity of the village. The shrub cover includes *Salix elegans, Berberis lycium, Rosa moschata, R. sericea, Indigofera pulchella, Cotoneaster affine, Spriaea arcuata, Rhamnus virgatus, Artemisia nilagirica, Lonicera quinqulocularis and Nepeta discolor.* Evergreen forests of *Cupressus torulosa* are found in the north direction.

The majorpastures for grazing livestock lies to the north of the village across the Tolma nallah. The approach

# TOLMA


N
DHAULI GANGA R.
TO JOSHIMATH
BHAUNRA PANI GADHERA
TOLMA GADHERA
400m.
500m.
600m.
800m.
800m.
1Km
1.2Km
1.5Km
2Km
2Km
KEY
SHEEP & GOAT
COW
TREES
SHRUBS
FUEL WOOD CUT
REGENERATION
CROPS
WILDLIFE
PASTURE
NEGATIVE INDICATORS
POSITIVE INDICATORS
Not to Scale

## PROFILE OF TOLMA

| | |
|---|---|
| Altitude | 2800 m |
| Total number of households | 22 |
| Average family size | 6 |
| Average land holding per family<br>(10 Nalis = approx. 1 Acre) | 56 Nalis |
| Average production of main crops<br>(kg/nali) | |
| Rajma *Phaseolus* sp. | 15 |
| Potato *Solanam tuberosum* | 150 |
| Amaranth *Amaranthus paniculatus* | 8 |
| Phaphar *Fagopyrum tataricum* | 17 |
| Jumbo *Allium stracheyi* | 2 |
| Wheat *Triticum aestivum* | 13 |
| Average crop damage<br>by wildlife | 15% |

Domestic livestock

| Bulls | Total cows | Milch cows | Jersey cows | Goats | Sheep | Horses | Total livestock |
|---|---|---|---|---|---|---|---|
| 49 | 78 | 39 | 8 | 105 | 163 | 0 | 442 |

Domestic livestock killed by leopard in last five years

| Bulls | Cows | Goat |
|---|---|---|
| 10 | 10 | 1 |

| | |
|---|---|
| School in the village | Primary school |
| Average level of literacy in the current generation | |
| Females | Males |
| Junior High School (Class VIII) | High School (Class X) |
| No of graduates in the village | 6 (all males) |
| No. of persons employed outside | 6 (all males) |
| Health services | Hospital at Jelam (29 km away) |
| Distance from motorable road | 5 kms |

to this area is through the forests in the eastern side and there the frequency occurrence of livestock grazing was found to be 4 in the first transect. The path goes down to the bridge after the first kilometer and subsequently zero grazing was observed in the following transects in this direction. The value of other negative indicators such as cutting for fuel wood (f.o.2) and timber (f.o.2) also reduced upon moving further east. The percentage occurrence of trees here was 30% for *Populus ciliata,* 20 % for *Cedrus deodora,* and 10% for *Betula utilis.* Tracks and pellet groups of Goral was also recorded here.

On a general basis it was noticed that forests close to agricultural fields and extending over gradual slopes were mostly used for collection of fuel wood. This is because people on their way back from the fields bring a load of fuelwood. The fields of Tolma are mostly to the west and the south. The relative advantage with the fields to the south is that the fields are located uphill and subsequently bringing loads down to the village is easier than walking up from the west . Therefor maximum amount of fuelwood cutting signs (f.o.4) were observed in forests to the north of Tolma village.

Young and aged livestock often cannot walk long distances to reach major grazing areas. They are left in the forests adjoining the fields to graze so that while working in the field people can keep an eye on them. Greater number of livestock grazing signs (f.o.8) were observed in the south than in the west (f.o.6). Beyond 2 km in the south and 1 km in the west no livestock signs were observed.

On the side of positive indicators after a walk of 45 minutes to the west near the ridge scats of red fox *(Vulpes vulpes)* and common leopard *(Panthera pardus)* were seen.

The limited forest to the north are not only used by the people of Tolma but also by the people of Suraithota. A big heap of dead logs to be rolled down along a seasonal stream (dry during the visit) was seen. It is easy to roll logs down to the Tolma nallah and then carry them to Suraithota and Gurma Gwad, the winter home for the people of Tolma.

## PHAGATI

Phagati and Punwasa are twin villages. While the former is used only in summer season the later is inhabited round the year. The same families own houses and land in both the villages. It is a three hour walk from Punwasa to Phagati involving a climb of 2500 feet. Even though Phagati is a shifting village, the same forest is used and utilised round the year. There is no Van Panchayat Forest available with either Phagati or Punwasa and all adjoining forests are Reserve Forests. Extensive forests occur on only two sides of Phagati village.

To the west of Phagati are predominantly *Pinus wallichiana* forests with shrub cover comprising of *Cotoneaster affine, Rhamnus virgatus, Desmodium elegans, Abelia triflora, Spiraea canescens, Sorbus foliolosa, Elshoultzia densa, Rubus foliolosus, Indigofera heterantha, and Viburnum cotinifolium.*

The transect laid at the end of the 15th minute of the walk revealed many signs of livestock grazing (f.o.6) lopping (f.o.3) fuelwood cutting and wood cutting for other purposes (f.o.2). Outside the transect seven blue pine trees in the girth class of 40-90 cms had been freshly logged. The overall value for negative indicators was three times that for the positive ones. The second transect was laid at a distance of approximately 3 Kms, after half an hour walk from the village in the same direction. Zero lopping and few signs of livestock and fuelwood cutting against a simultaneous increase in the value of positive indicators with sighting of musk deer pellet groups (f.o.2) and increased availability of useable fallen wood (f.o.2) and a considerable rise in the percentage occurrence of trees suggests that the forests are in a much better shape here.

A huge rock at the end of the transect creates a natural barrier for any further approach in the western direction. The same rock face does not allow human and livestock movement from the south also. To the south lies Gurma Gwad which is the winter season home of the people of Tolma. This makes possible the existence of a reasonably big chunk of absolutely pristine forest beyond the rock face till the end of the ridge.

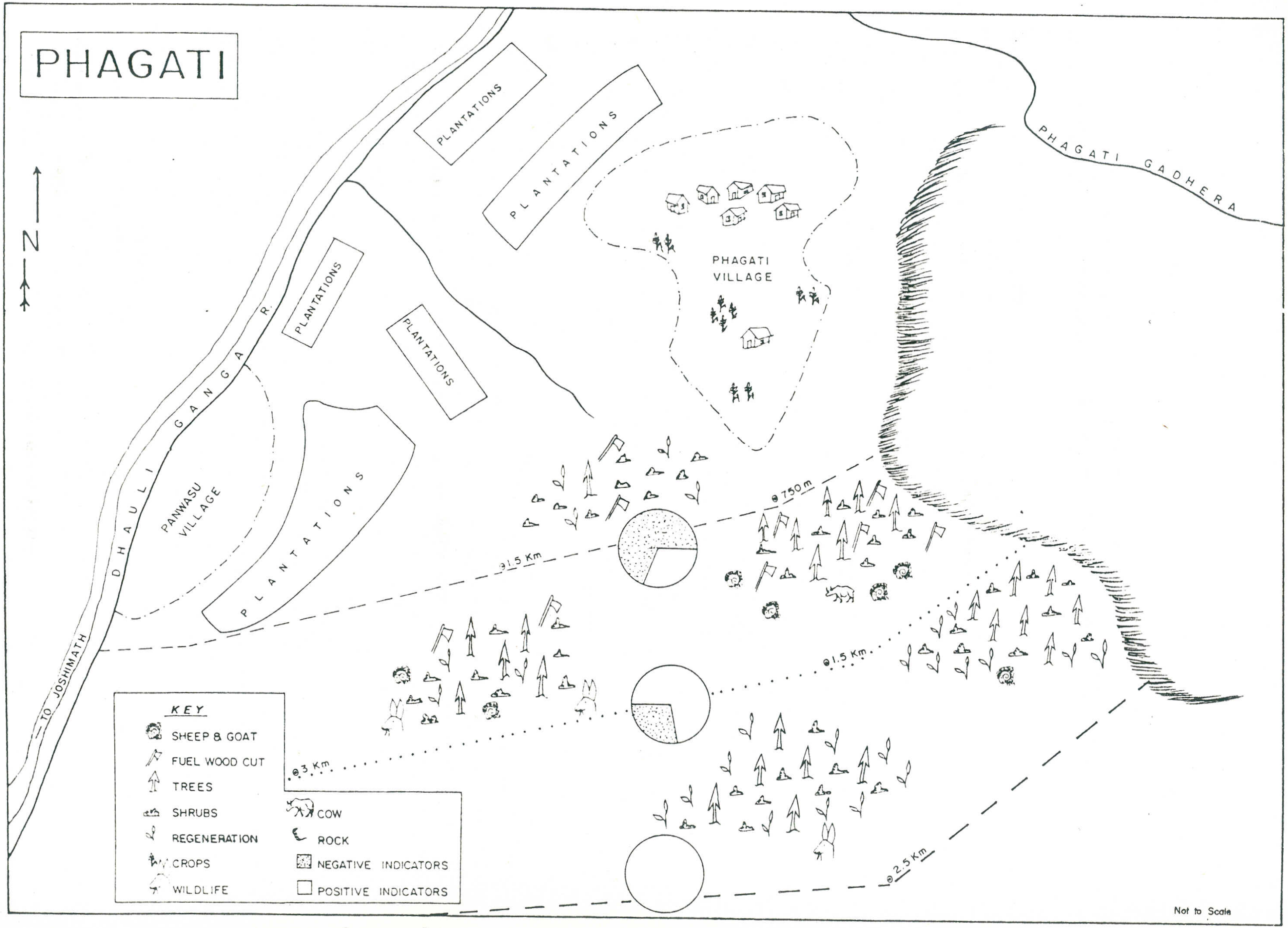
The whole hill side to the south of Phagati is well forested. It is a steep climb uphill. In the lower reaches of the slope tree cover is dominated by *Pinus wallichiana* and associate species are *Abies pindrow, Acer cappadocium, Betula utilis, and Taxus baccata.* The shrubs include *Sorbus foliolosa, Salix elegans, Berberis pseudumbellata, Indigofera pulchella, Cotoneaster affine, C.bacillaris, Abelia triflora, Viburaum cotinifolium and Lonicera angustifolia.* Signs of fuelwood cutting (f.o.5) grazing by livestock (f.o.4) lopping (f.o.2) and cutting of bamboo shoots (f.o.1) suggest the regular use of this area also by the villages. A cluster of old musk deer pellets was also seen in this area.

Going up the steep slope a distance of approximately 1.5 km only could be covered in half an hour from the village. The predominantly blue pine forest here contains *Populus ciliata* in addition to *Betula utilis* and *Taxus baccata.* In the shrub cover two species of Rhododendron i.e. *R.campanulatum* (p.o.30%) and *R.lepidotum* (p.o.10%) start occurring along with *Salix elegans* and a different species of Berberis i.e. *B.aristata.* The forest is practically completely undisturbed except for a single observation of livestock grazing in the whole transect. Plenty of regeneration was observed in almost all the tree species occurring here. However no wildlife signs were observed, within the transect.

The last transect was laid near to the top of the ridge on this north facing slope south to the village. The composition of the forest is *Desmodium elegans* (p.o.10%) *Abies pindrow* (p.o.10%) *Betula utelis* (p.o.20%) *Pinus wallichiana* (p.o.20%) as the tree layer. The shrubs present are *Salix elegans* (p.o.30%), *Sorbus foliolosa* (p.o.20%) and *S.microphylla, Rhododendron lepidotum* and *R.campanulatum* each recording ten percentage occurrence. There was not a single observation of any negative indicator. On the positive side one fresh pellet cluster of musk deer within the transect and three pellet cluster (2 old & 1 fresh) of musk deer outside the transect were observed.

This absolutely pristine area cannot be treated as virgin forest because people do visit it in search of morel mushrooms *(Morchella esculenta)* and wild plant sources of vegetables and spices such as the leaves of

# PHAGATI


N
TO JOSHIMATH
DHAULI GANGA R.
PANWASU VILLAGE
PLANTATIONS
PLANTATIONS
PLANTATIONS
PLANTATIONS
PLANTATIONS
PLANTATIONS
PHAGATI VILLAGE
PHAGATI GADHERA
@750m
@1.5 Km
@1.5 Km
@3 Km
@2.5 Km
KEY
SHEEP & GOAT
FUEL WOOD CUT
TREES
SHRUBS
REGENERATION
CROPS
WILDLIFE
COW
ROCK
NEGATIVE INDICATORS
POSITIVE INDICATORS
Not to Scale

## PROFILE OF PHAGATI

| | |
|---|---|
| Altitude | 3000 m |
| Total number of households | 20 |
| Average family size | 6 |
| Average land holding per family (10 Nalis = approx. 1 Acre) | In Phagati 13.2 Nalis<br>In Punwasa 5.9 Nalis |
| Average production of main crops (kg/nali) | |
| Rajma *Phaseolus* sp. | 10 |
| Potato *Solanam tuberosum* | 125 |
| Amaranth *Amaranthus paniculatus* | 11 |
| Phaphar *Fagopyrum tataricum* | 12 |
| Average crop damage by wildlife | 10% |

Domestic livestock

| Bulls | Total cows | Milch cows | Jersey cows | Goats | Sheep | Horses | Total livestock |
|---|---|---|---|---|---|---|---|
| 40 | 51 | 12 | 1 | 542 | 507 | 0 | 1153 |

| | |
|---|---|
| Domestic livestock killed by leopard in last five years | 3 cows |
| School in the village | Primary school |

Average level of literacy in the current generation

| Females | Males |
|---|---|
| Junior High School (Class VIII) | High School (Class X) |

| | |
|---|---|
| No of graduates in the village | 6 (all males) |
| No. of persons employed outside | 7 (all males) |
| Health services | Hospital at Jelam (20 km away) |
| Distance from motorable road | 6 kms |

*Smilacina purpurea* (Puyandu), *Paeonia emodi* (Chandra) and the roots of *Pleurospermum, angelicoides* (Choru) etc. However there was no degradation observed in the forest on account of this minor forest product (MFP) extraction. Although it offen happens that the number of the particular species being harvested continues to decline over the years without causing any visible damage to other plant and animal associates. No such study is available for sustainable limits of harvest of these species in the temperate and sub-alpine forests of this region. However the local users confirmed that the availability of any of these species over the years has not declined and so it can be said that the forest is being used only for selective MFP extraction well within sustainable limits.

## DUNAGIRI

Dunagiri derives its name from Parvat Raj Dronagiri, the hill from where Hanuman brought the Sanjivini herb for Laxman. This village is located at 3500m and is highest amongst all the villages surveyed. It is so cold here that the inhabitants spend only five peak summer months(from May to September) in the area. They shift to Maithana near Chamoli every winter. Each family has got a house in each of the two villages .

Forests adjoining Dunagiri primarily comprise of *Betula utilis* together with *Rhododendron campanulatum, Sorbus foliolosa* and *Salix elegans.* The forests on the eastern side join with the bugyal (alpine meadows) after about 7 kms. The forests in the South too join with the bugyal after a narrow strip averaging about four kms in width and a kilometer in length. Movement further south west to this area is obstructed by a narrow strip of glacial moraine, beyond which lies a chunk of birch forest about 4 Sq.Km in size. This is relatively the best protected patch.

Lakhi, the breed of goat used to transport loads from the road head to the village, alone constitutes 60% of the total domestic livestock in the village. This is also the only village out of all the four studied where ponies are reared. The lopping of birch trees to feed Lakhis and other livestock is evenly spread all over the forests in the south as well as in the east with their frequency occurrence ranging from 3 to 4. However there is little of direct grazing pressure within the forest except on the edges of the bugyal and the approach to bugyals. Most of the grazing takes place in the bugyal located to the north of the village across the Dunagiri Nallah.

The pressure on account of wood cutting for fuelwood is also marginal because a lot of useable fallen wood is available after heavy snow fall and glacial movements during the severe winters. The fallen leaves of Rhododendron bushes are picked up from the forest floor and this litter is used to prepare bedding for the livestock. Later this litter along with dung is used as manure.

In terms of presence of wildlife one Serow pellet group was recorded and Monal was heard twice in the third transect in the east direction. To the south one fresh pellet group of Musk deer was sighted in the second transect, at a distance of about three kilometers from the village.

The trend in the recent years has been that only a few members of each family shift to Dunagiri from Maithana during summer. They mainly come here to graze the livestock and cultivate the fields. The younger generation is not so willing to face the hardship of living here. With this lack of sufficient manpower quite a bit of the agricultural land lies fallow round the year. The size of the herd of livestock has also been gradually decreasing because of decline in access to various pastures in the traditional grazing areas (foothills of Garhwal and Kumaon, Bhabar and the Terai regions). This is likely to further improve the status of forests around Dunagiri in future.

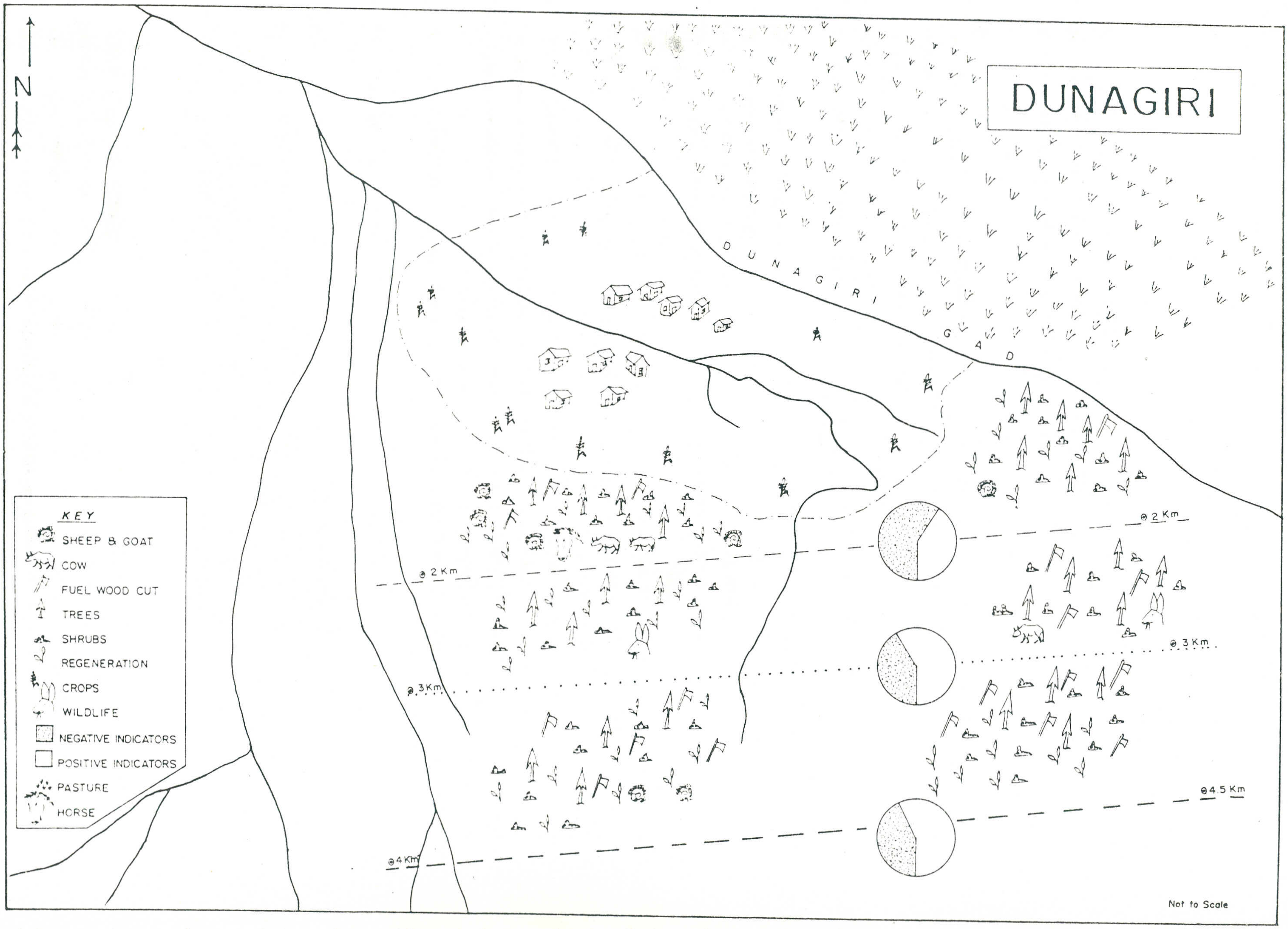
Dunagiri village falls enroute to the patrolling areas for the Indo Tibetan Border Police (ITBP). In the past temporary camps of ITBP have been established near the glacier to the east of the village. The frequency occurrence of fuel wood cutting was observed highest in this part of the forest. If in future the intensity as well as frequency of such patrols increases this is likely to further damage the forests. This remains by and large the only external factor of concern for the future of these forests.

## RECOMMENDATIONS

The Nanda Devi Biosphere Reserve authorities have recently drawn up a management plan for a five year period staring from financial year 1993-94. The salient features of the plan include financing the animal husbandry department for immunisation of domestic livestock in the villages of the buffer zone, supporting infrastructural development in the villages by financing the PWD to improve the paths leading to the villages from the motorable roads and providing subsidy to the villagers for putting up solar lighting, smokeless chulhas etc. with the help of the Department of Nonconventional Energy Sources. The working plan also intends setting up a meteorological station to monitor climatic parameters, establishing nurseries (including one for medicinal plants) and taking up plantation work and establishing a nature interpretation centre. The plan intends creating the infrastructure and posts to manage the Kumaon portion of the buffer zone and purchasing equipment such as arms and ammunition, wireless sets etc. to enhance the level of protection. The total expenditure envisaged to attain all this is Rs.42.2 million. Since the declaration of the Biosphere Reserve in 1988 a total expenditure of Rs. 6.5 million has already been incurred until the end of the financial year 1991-92. (Management Action Plan for the Nandadevi Bisophere Reserve, 1993-94 to 1997-98)

The ambitious plans of the NDBR management and the requirement of these major funds raises some valid questions which need to be answered. Is this financial outlay really neccessary to conserve NDBR, particularly when all evidence gathered indicates that the forests are still in good condition. Will this one time expenditure spread over a period of five years ensure sustainable conservation for all times to come or will this lead to inflated reccurring expenditure? Can 'model' villages be created at all with external capital investment?

A case in point is that of the Phagati village. The NDBR management has invested more than a million rupees in this village over the last few years. Money has been spent in making a cemented path to Punwasa village and repairing of the path leading to Phagati, construction of retaining walls to prevent landsilides at two


DUNAGIRI
N
KEY
SHEEP & GOAT
COW
FUEL WOOD CUT
TREES
SHRUBS
REGENERATION
CROPS
WILDLIFE
NEGATIVE INDICATORS
POSITIVE INDICATORS
PASTURE
HORSE
DUNAGIRI GAD
2 Km
3 Km
4 Km
2 Km
3 Km
4.5 Km
Not to Scale

## PROFILE OF DUNAGIRI

| | |
|---|---|
| Altitude | 3500 m |
| Total number of households | 45 |
| Average family size | 7 |
| Average land holding per family (10 Nalis = approx. 1 Acre) | 28 Nalis |
| Average production of main crops (kg/nali) | |
| Potato *Solanam tuberosum* | 110 |
| Amaranth *Amaranthus paniculatus* | 10 |
| Phaphar *Fagopyrum tataricum* | 9 |
| Cheena *Panicum milliaceum* | 7 |
| Average crop damage by wildlife | 5% |

Domestic livestock

| Bulls | Total cows | Milch cows | Jersey cows | Goats | Sheep | Horses | Total livestock |
|---|---|---|---|---|---|---|---|
| 33 | 69 | 17 | 0 | 500 | 190 | 17 | 826 |

| | |
|---|---|
| Domestic livestock killed by leopard in last five years | None |
| School in the village | Primary school |

Average level of literacy in the current generation

| Females | Males |
|---|---|
| Junior High School (Class VIII) | High School (Class X) |
| No of graduates in the village | No information |
| No. of persons employed outside | No information |
| Health services | Hospital at Jelam (21 km away) |
| Distance from motorable road | 14 kms |

locations, creating a nursery and undertaking plantations on five sites in nine phases spread over on area of 99 hectares.

All these plantations were done in the traditional grazing lands between Phagati and Punwasa. The terrain was steep and rocky. The raising of plantations in the area caused problems to the shepherds who began grazing their livestock in new pastures further into the buffer zone. (Post monsoon grass harvesting is permitted within the plantations). 30 % of the saplings in this 35 ha. plantation done in 1989 had to be replaced in the following two years. Finally, realising that trees do not do well in that terrain most of the gaps were planted with shrubs (22000 seedlings) and grasses in 1992-1993. The five main species of shrubs selected were *Sorbus foliolosa, Berberis lycium, Wikstroemia canescens, Viburnum cotinifolium* and *Ameos* spp. Out of these, only *Viburnum cotinifolium* is a good fodder species. To summarise, this plantation effort has made little impact on improving the natural resource base. Inspite of being a source of income generation for the villagers through remuneration for operations such as digging, weeding etc., it has only bought their illwill because a scheme to improve their grazing lands resulted finally in the loss of it. Welfare expenditure out of conservation money is often justified on the basis of building the trust of the people in the long term plans of the protection agency. As has been illustrated before, the NDBR management in its attempts to demonstrate Phagati as an 'ideal' or model village invested in making a road to the village. This act of development, however has backfired. The reserve forest at Phagati village was the only location amongst those surveyed where green trees had been felled. Seven trees of blue pine (with an average gbh of over 60 cms) had been logged.

The rationale for determining the balance between conservation spending and welfare spending needs to be based on a realistic understanding of the problems facing sustainable conservation of the NDBR. Going by conceptually flawed notions about a 'holistic' approach can be counter productive.

### Core Zone

The core zone of the NDBR is blessed with a high ring of mountain peaks and the most accessible pass at Dharansi is also 14000 ft high. There are no anthropogenic pressures inside this area except for visits by poachers and mountaineering and trekking enthusiasts. Mountaineering and trekking have been banned since 1982 and only the problem of poaching remains. In discussions with the villagers and NDBR staff it was revealed that the bulk of the poachers come from parts of Kumaon and Nepal. They avoid the Dharansi route for the fear of being seen by the locals and the wildlife guards.

The most accessible other route starts from Bagrigad which is the last village on the road coming from Tharali via Deval. The various camps enroute from Bagrigad to Bethartoli (inside the core zone) are as follows. Monduli, Lohjang, Ban, Wan, Ranka Ghat, Garuli Patal, Pater Nachuniya, Roop Kund, Joragali, Silasamudra and Hemkund. This trek, from Bagrigad to Bethartoli takes about five to six days. Vigilance measures should be increased by appointing wildlife watchers from the villages enroute.

## Buffer Zone

It follows from the discussions on the conservation status of forests around the villages that the evidence of forest degradation is relatively insignificant. The intensity of current use appears well within the production level of the forests and spread within a reasonable distance from the villages. There are neither any licensed commercial ventures nor are there widespread illegal activites. However, certain measures can be taken up to further improve the conservation prospects.

As mentioned earlier, a lot of agricultural land is lying fallow in some villages on account of migration from the villages and lack of interest in the current generation towards traditional farming. There is scope for promoting more remunerative agro-practices like cultivation of medicinal plants etc. Initiative has already been taken by some farmers in Dunagiri who have successfully grown *Sassuria costus* (Kuth) and *Aconitum heterophyllum* (Atis) in their small experimental plots. The initial plant material was brought from the neighbouring forest area. At the current time they are facing the problem of mass propogation and adequate marketing support, for which they definitely need proper assistance.

Another highly remunerative venture is the oil of apricot *Prunus armeniaca.* It is extensively cultivated in this area. The cotyledons of the seed yield oil which the villagers extract for home consumption using traditional methods. More efficient technology for the cold pressing method maybe employed to manufacture this highly priced commodity in marketable quantities. These kinds of ventures involving local value addition should be facilitated.

Marketing problems exist for even the traditional crops such as *Rajma, Phaseolus spp.* and potatoes, because of the added transportaion costs in bringing it down from the villages to the motorable roads. Since most of these crops are cultivated without using chemicals they can be marketed at a relatively higher price in cities. In addition some of the local crops such as amaranth *(Amaranthus paniculatus)*, cheena *(Panicum miliaceum)* and phaphar *(Fagopyrum tataricum)* can be marketed as breakfast cereals. Facilitating such marketing linkages and innovative selling techniques would go a long way in improving the already 'not so bad' agro-economy of this area.

As for the forests of NDBR the best policy would be to leave them alone.

# APPENDIX 1

## LOCAL NAMES OF SOME IMPORTANT SPECIES DESCRIBED IN THE TEXT

| BOTANICAL NAME | COMMON NAME |
|---|---|
| *Abelia triflora* | Kimyedu |
| *Abies pindrow* | Raga |
| *Acer cappadocium* | Kanchula |
| *Artemisia nilagirica* | Kunja |
| *Arundinaria falcata* | Ringal |
| *Berberis aristata* | Choutru |
| *Berberis lycium* | Kilmora |
| *Berberis pseudumbellata* | Chaiter |
| *Betula alnoides* | Katbhoj |
| *Betula utilis* | Bhojpatra |
| *Cedrus deodara* | Deodar |
| *Celtis australis* | Kharik |
| *Cotoneaster affine* | Ruins |
| *Cotoneaster bacillaris* | Dhuins |
| *Cupressus torulosa* | Surai |
| *Desmodium elegans* | Chalmara |
| *Desmodium wallichiana* | Bains |
| *Deutzia staminea* | Cher |
| *Indigofera heterantha* | Sholu |
| *Indigofera pulchella* | Sakeena |
| *Juglans regia* | Akhrot |
| *Lonicera angustifolia* | Satbokri |
| *Lonicera quinqulocularis* | Bhadru |
| *Nepeta discolor* | Ghudku |
| *Pinus wallichiana* | Kail/Blue Pine |
| *Populus ciliata* | Syan/Poplar |
| *Prunus armenica* | Chuli |
| *Prunus persica* | Kirul |
| *Rhododendron anthopogon* | Nanangor |
| *Rhododendron campanulatum* | Angod |
| *Rhododendron lepidotum* | Tains |
| *Rosa moschata* | Kigri |
| *Rosa sericea* | Shidum |
| *Rubus foliolosus* | Hisol |
| *Salix elegans* | Boksa |
| *Skimmia laureola* | Nairpati |
| *Sorbus foliolosa* | Sholu |
| *Sorbus microphylla* | Panao |
| *Spiraea arcuata* | Chadlu |
| *Spiraea canescens* | Mario |
| *Taxus baccata* | Thuner |
| *Toona serrata* | Darli |
| *Viburnum cotinifolium.* | Ghyunu |
| *Wikstroemia canescens* | Syuu |
| *Litsea umbrosa* | Chirad |

# DIVERSITY AND STATUS OF PLANTS IN NANDA DEVI BIOSPHERE RESERVE

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## Introduction

Indian Himalaya, extending from Jammu and Kashmir in the north and Arunachal Pradesh in the east is known for its national heritages. It has a large diversity, rich flora and fauna. Majority of the important species such as endemic, threatened and economically important species are found in this region and is a germplasm centre of all the important species.

Nanda Devi Biosphere Reserve located in the Indian Central Himalaya, is a famous World Heritage site. It forms a transistion zone between Western and Eastern Himalaya and is known for its habitat, floral and faunal diversity.

The only detailed study of this region was made by Hajra (1983). He reported 312 species distributed over 199 genera and 81 families. This information includes the collection of two trips i.e., August - September, 1981 and June - July, 1982. Since then, this area was completely protected and no human interference was allowed inside the core area.

To review the status of flora and fauna, the Ministry of Environment and Forests, sponsored a joint Scientific and Ecological Expedition alongwith the Corps of Engineers.

## OBJECTIVES

1. Inventory of vascular plants (Angiosperms, Gymnosperms and Pteridophytes).
2. Assessment of habitat diversity and floristic diversity.
3. Natural resource utilisation pattern of villagers within Nanda Devi Biosphere Reserve.
4. Identification of status of plants and prioritisation for conservation.

## METHODS

During the period of expedition, May and June 1993, localities namely Murana, Kalikona, Chinnabari, Dudh Ganga, Pangrani, Dibrugeta, Malla Dibrugeta, Barapani, Deodi, Malla Deodi, Trishula nullah, Ramni, Bagni gathera, Bhujgara, Patalkhan, Sarsopatal, North Sanctuary, base camp area, Dharansi, Lata kharakh, Himtoli, Belta kharakh and adjacent areas of Lata and Reni villages were surveyed. The study was undertaken between 2000 and 5000 m asl. Field identification of plants were made with the help of floras, research papers and reports (Hajra, 1983; Naithani, 1984; Rawat, 1984; Osmaston, 1927; Pangtey etal.,1988,POlunin&Stainton,1984,Pangtey&Samant,1987, Pangtey et. al., 1992; Khullar et. al., 1991 and Pantey & Punetha, 1987). Observations were made on the range of distribution, habit, habitat and population size of each species.

For the natural resource utilisation patterns of three villages namely, Lata, Reni and Peng, two knowledgeable persons from each village were interviewed. In addition, field visits were made with locals to identify species of economic importance. For each species, local name, botanical name, part(s) used and mode of utilisation was noted.

Rarity of the plants was analysed on the basis of habitat, population size, distribution range and utility.

## VEGETATION

The unique geographical location, climate and topography of the area helps flora and fauna in thier better survival. It has large altitudinal range and extends from temperate to alpine regions.Depending upon the altitudes and floristic composition the following types of vegetation are indicated.

### I.Temperate forests:

They are found to occur between 2,000 - 2,800m and are of two types: (a) Deciduous forests which are found in Murana and Chinwari and includes deciduous broad leaved species. The common tree species are *Acer cappadocium, Jugalns regia, Corylus jacquemontii, Celtis australis, Populus ciliata, Betula alnoides* and *Meliosma dilleniaefolia.* Shrubs such as *Rubus niveus, Desmodium elegans, Viburnum continifolium, Deutzia staminea* and *Arundinaria falcata* are common in the middle layer. (b) Evergreen forests which are found alongwith the deciduous forests in Murana and Chinwari and dominated by the coniferous trees. *Picea smithiana, Pinus walliachiana* and *Quercus floribunda* are the dominant species and middle canopy was dominated by *Sarcococca saligna, Rosa moschata* and *Arundinaria falcata.*

### II. Subalpine forests:

They occur betwen 2,800 - 3,800m and are of two types: (a) Deciduous forests which are distributed in Dudh Ganga,LataKharak, Sainikharak,Himtoli,Dibrughetta,Deodi,Trishul nullah,Ramni,Bagnidhar,and Bhujgara. *Acer acuminatum, , Prunus cornuta, Salix disperma ,Populus ciliata,andSorbus foliolosa* are the dominant tree species of the forest and supported by shrubs such as *Ribes glaciale, Sarcococca saligna, Salix denticulata, Desmodium elegans,, Viburnum continifolium, Rosa sericea, Lonicera webbiana Rhododendron campanulatum, Syringa emodi, Sorbus foliolosa, Cotoneaster affine* and *Piptanthus nepalensis* (b) Evergreen forests occur in the same localities These are dominated by *Abies pindrow,A.spectabilis ,Pinus wallichiana* and *Taxus baccata*. The other associates are *Taxus baccata,Betula utilis, Prunus cornuta*, and *Acer acuminatum*. The middle layer is dominated by Smilax vaginata, Rosa macrophylla, R.serica, Lonicera angustifolia, Sorbus foliolosa, Berberis aristata, Inula cuspidata and Ribes himalense.

### III. ALPINE SCRUBLANDS :

Above treeline, between 38.00 and 4,500m scrubs namely *Rhododendron anthopogon, R.lepidotum,* *R.campanulatum, Juniperus indica, J.recurva, Cotoneaster microphylla, C.integrifolius, Berberis umbellata, Cassiope fastigiate, Salix karelinii, S.hylematica, S.calyculata, S.lindleyana, Lonicera spinosa* and *L.obovata* are found growing luxuriantly and forms peculiar associations. The common associations are:

(i) Rhododendron - Cotoneaster association includes species such as *Rhododendron lepidotum, R.anthopogon, Cotoneaster microphylla* and *C.integrifolius.*

(ii) Piptanthus - Cotoneaster - Rhododendron association includes species such as *Cotoneaster mcirophylla, Piptanthus nepalnesis* and *Rhododendron lepidotum.*

(iii) Salix - Rhododendron association includes species such as *Salix karelinii, S.hylematica, S.lindleyana* and *Rhododendron anthopogon.*

(iv) Juniperus - Lonicera association includes species such as *Juniperus indica, J.recurva, Lonicera spinosa* and *L.obovata.*

(v) Rhododendron - Cassiope association: Species are *Rhododendron anthopogon* and Cassiope *fastigiata.*

## IV. ALPINE MEADOWS :

These are mainly dominated by herbaceous species. Few scrubs such as *Juniperus indica, Lonicera obovata, Rhododendron anthopogon, Cassiope fastigiata, Salix hylematica* and S. Rindleyana are often found in the meadows.

The herbaceous species of the meadows are *Tanacetum tomentosum, Iris kumaonensis, Nomocharis oxypetala, Artemisia maritima, Allium wallichii, A.humile, A.stracheyi, Leontopodium himalayanum, Dactylorhiza hatagirea, Geranium wallichianum, Cortia depressa, Anaphalis contorta, A.busua, Sibbaldia purpurea, Rhodiola bupleuroides, Potentilla astrosanguinea, P.argyrophylla, Thymus linearis, Polygonum affine, Anemone rupicola, A.obtusiloba, Danthonia cachemiriana, Carex nubigena, C.nivalis, Primula denticulata, Pedicularis hoffmeisteri, P.bicornuta, Thalictrum alpinum, Lloydia serotina, L.longiscapa, Jurinea himalaica, Gentiana argentea, G.carinata, Parnassia nubicola, Geum roylei, Bupleurum candollei, Taraxacum officinale.*

## V. MORAINES:

The characteristic species of the moraines are *Saxifraga pulvinaria, S.hemisphaerica, Androsace globifera, Waldheimia tomentosa, Ephedra gerardiana, Potentilla argyrophylla, P.fruticosa, Tanacetum tomentosum, Hedysarum kumaonense* etc.

## RESULTS & DISCUSSION

### 1. Plant diversity:

The work on the flora of Nanda Devi National Park was done by Hajra (1983). He reported 312 species, 199 genera of 81 families belonging to Angiosperms, Gymnosperms and Pteridophytes. The present work done includes 620 species in 344 genera of 116 families(including old records )of Angiosperms, Gymnosperms and Pteridophytes (Table 1) and adds 308 species, 145 genera and 35 families in the previous works (Table 2).

The dominant families of the Angiosperms are Asteraceae (42 species), Rosaceae (39 species), Ranunculaceae (32 species), Poaceae (28 species), Orchidaceae (21 species), Fabaceae (19 species) respectively.In Gymnosperms, dominant families are Pinaceae (5 species), Cupressaceae (4 species), and in Pteridophytes dominant families are Dryopteridaceae (14 species), Athyriaceae (13 species), Aspleniaceae (8 species) and Polypodiaceae (8 species) respectively.

Thirty six families of Angiosperms, two families of Gymnosperms and nine families of Pteridophytes are with one species only (Appendix - I).

### 2. Habitat diversity:

Habitat diversity of a plant species is a peculiar factor which help in the identification of rarity. Species with restricted habitat have more chances of extinction than the species with broad habitat types. A species with large local population sizes and wide geographic range that is restricted to a single habitat is not likely to benefit from transplants as a method of conservation. On the other hand, a plant species with a narrow range and large local populations in a broad range of habitats may benefit from transplants. The study of habitat diversity may help in the prioritisation of the species for conservation. The habitat diversity of each species is given in Appendix - I.

### 3. Rarity:

Plant species may be rare due to the restricted habitat, small population size, narrow range of distribution and over exploitation for commmercila purposes. There are many species within the core zone of the area whcih need complete protection and prioritization for conservation in a fairly similar PAN (Table 3). These species have restricted habitats, small population sizes and localised distribution but there are some rare species which have wide distribution range, small population and restricted habitats.

Species with large population sizes,wide range of distribution and broad habitats are common in occurence. Seven species which have been placed in the Red Data Book were noticed from the NDBR(Table 4).

## NATURAL RESOURCE UTILISATION PATTERN

### Wild resources:

The people inhabiting the villages of the Biosphere Reserve use various plant parts as medicine,food,fodder,fuel,cultivated tool,house building,fibres,religious and other purposes.A total of 97 species are being utilized by local people.Out of these 17 species are used as medicine, 55 as food (edibles), 15 as fodder, 16 fuel, 5 cultivated tools, 8 house builidng, 2 fibres, 6 miscellaneous and 11 religious purposes (Table 5).

**Cultivated resources:**

(i) Crops: *Fagopyrum esculentum* (Oogal), *F.tataricum* (Phapar), *Phaseolus lunatus* (Rajma), *Eleusine coracana* (Maduwa), *Amaranthus paniculatus* (Chaulai), *Solanum tuberosum* (Aalu), *Hordeum himalense* (Uwa), *H.vulgare* (Jau), *Glycine max* (Bhatt), *Triticum aestivum* (Gahoon), *Lens esculenta* (Masoor), *Brassica campestris* (Sarson) and (China) are the main crops cultivated by the local people for food.

(ii) Vegetables: The main vegetables of the villagers are *Brassica alba* (Rai), *Spinacea oleracea* (Palag), *Brassica oleracea* (Gobhi), *Lycopersicon esculentum* (Tamatar), *Trigonella foenum-graecum* (Methi), *Solanum melongena* (Baigan), *Solanum tuberosum* (Aalu), *Phaseolus lunatus* (Rajma), Cucurbita maxima (Kaddu), *Lagenaria vulgaris* (Launki), *Fagopyrum tataricum* (Phapar) and *Raphanus sativus* (Mooli).

Fruits: The fruit plants cultivated by the villagers are *Pyrus communis* (Naspati), *P.malus* (Seb), *Jugulans regia* (Akhruwa), *Prunus persica* (Aru), *P.armeniaca* (Khumani), *P.ceracifera* (Padum) and *Vitis vinifera* (Angoor).

## CONCLUSION

The study carried out within the two months (May & June) is not sufficient to analyse the plant diversity of the Biosphere Reserve. Every plant species has its own time of growth and flowering. Therefore, survey in different seasons of a year is necessary for analysing the plant diversity.

Over exploitation for commercial purpose and destruction of habitat of a species have caused rapid decrease in the population size throughout the globe. The people residing within the Biosphere Reserve of the area are dependant on the biological resources to meet their economy. They use parts of various plants and exploit their population and habitats. The population of these plants is decreasing in an alarming rate. Therefore, there is an urgent need to make people aware about the status of these plants, their utilisation in a sustainable manner and propagation of these species in fairly similar PAN. For this training and extension programmes should be launched throughout the villages of buffer zone of the Biosphere Reserve.

Habitat conservation is a prime step for the conservation of a species. Therefore, it is envisaged that the core zone of the Biosphere Reserve should be completely protected and preserved. It shall help in the sustainance of the habitat diversity.

Planned scientific study in different seasons should be carried out after a gap of every three years to review the status of the flora and fauna. This would help in the mangement and monitoring of the Biosphere Reserve.

The buffer zone is equally good for its flora and fauna. Therefore, development of tourism in the bufferzone may employ local people and would help in keeping them busy ultimately in decreasing the pressure on the sensitive biological resources.

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## Table 1. Analysis of the Flora

| Groups identified | Family | Genera | Species | Herbs | Shrubs | Trees |
|---|---|---|---|---|---|---|
| Angiosperms | 91 | 303 | 531 | 392 | 104 | 32 |
| Gymnosperms | 4 | 8 | 11 | - | 4 | 7 |
| Pteridophytes | 21 | 33 | 78 | 78 | - | - |
| Total | 116 | 344 | 620 | 470 | 108 | 39 |

## Table 2. Comparision of the present work with the previous work

| Groups identified | Present study | | | Previous study | | |
|---|---|---|---|---|---|---|
| | Families | Genera | Species | Families | Genera | Species |
| Angiosperms | 91 | 303 | 531 | 67 | 182 | 293 |
| Gymnosperms | 4 | 8 | 11 | 4 | 6 | 6 |
| Pteridophytes | 21 | 33 | 78 | 10 | 11 | 13 |
| Total | 116 | 344 | 620 | 81 | 199 | 312 |

## Table:3 Rare Plants of Nanda Devi Biosphere Reserve

**I. Angiosperms:**

| Taxa | Family | Locality | Altitudinal range(m) | Habitat/s |
|---|---|---|---|---|
| Aconitum balfourii Stapf. | Ranunculaceae | Deodi Trishul nullah | 3000-4500 | Forests, |
| A. folconeri Stapf. | -do- | Ramni | 3515 | Forests |
| A. heterophyllum Wall. ex Royle | -do- | Chhinabari | 2400-2700 | Forests |
| A. violaceum Jacq. ex Stapf. | -do- | Dibrughetta | 3000-4000 | Forests |
| Callianthemum pimpinelloides (D.Don) HK.f.& Th. | -do- | North sanctuary, Sarsaupatal | 4000-4600 | Alpine slopes, rock under - growth. |
| Ranunculus pulchellus Mey. | -do- | Sarsaupatal | 4000-4500 | Mash/wet land |
| Circaeaster argrestis Maxim | Circaeastraceae | Deodi | 3350 | Rock crevices, under bouldrs. |
| Berberis edgeworthiana Schneid. | Berberidaceae | Himtoli | 3000-3600 | Forests |
| B.kumaonensis Schn. | -do- | Dibrughetta to Deodi | 3000-3500 | Alpine slopes, shrubberries |
| Podophyllum hexandrum Wall. ex Royle | Podophyllaceae | Deodi, Dibrughetta | 2800-3600 | Forests, within boulders |
| Meconopsis aculeata Royle | Papaveraceae | Sarsaupatal | 3500-4500 | Rocks |
| Corydalis sikkimensis (Prain.) Fedde. | Fumariaceae | Bhujgara Ramni | 3500-4200 | Alpine slopes |
| Megacarpaea polyandra Benth. | Brassicaceae | Malla Dibrughetta | 3500-4000 | Shrubberries, Alpine slopes. |
| Astragallus candolleanus Royle ex. Benth. | Fabaceae | North sanctuary | 3300-4200 | Alpine slopes |
| Pyrus lanata D.Don | Rosaceae | Malla Chhinabari | 2800 | Forests |
| Pleurospermum angelicoides (DC.) Cl. | Apiaceae | Dibrughetta | 2800-3500 | Forests |
| Angelica glauca Edgew. | -do- | Trishul nullah | 3500-4000 | Forests, shrubberries. |
| Cortiella hookeri (Cl.) Norman | -do- | Sarsaupatal | 4200-4500 | Alpine slopes |
| Lonicera asperifolia (Dune) HK.f. & Th. | Caprifoliaceae | North sanctuary | 4200 | River bank |
| Triosteum himalayanum Wall. | -do- | Beltakharak | 2800-300 | Forests |
| Nardostachys grandiflora DC. | Valerianaceae | Bhujgara | 3500-4200 | Rocks, Rock, crevices. |
| Waldheimia tomentosa (Decne) Regel | Asteraceae | Sarsaupatal | 4000-4700 | Morains |
| Saussurea costus (Falc.) Lipsch. | -do- | Deodi | 3300-3600 | Forests |
| Primula glomerata Pax. | Primulaceae | Sarsaupatal | 3500-4200 | Alpine pastures |
| P. involucrata Wall. ex. Duby | -do- | -do- | 4000-4200 | Marsh/wet land, near water courses |
| Cynanchum canescens (Willd.) Schum. | Asclepiadaceae | Between Dibrughetta and Deodi. | 3000-3500 | Alpine slopes, forests |
| Rheum speciforme Royle | Polygonaceae | Patalkhan | 3600-4300 | Alpine slopes |
| Arnebia benthamii (Wall. ex.G.Don) Johnston | Boraginaceae | Trishul nullah | 3300-4000 | Alpine pastures |
| A. euchroma (Royle) Johnston | -do- | Sarsaupatal | 4000-4500 | Alpine pastures |

| | | | | |
|---|---|---|---|---|
| Picrorhiza kurrooa Royle ex. Benth. | Scrophulariaceae | Trishul nullah | 3300-4000 | Land slide areas |
| Cypripedium elegans Reichb. | Orchidaceae | Dharansi | 3800 | Alpine slopes |
| C. himalaicum Rolf. | -do- | Dibrughetta | 3400 | Alpine pastures |
| Dactylorhiza hatagirea (D.Don) Soo | -do- | Dibrughetta, Latakharak | 3200-3600 | Alpine pastures |
| Gymnadenia orchidis L. | -do- | Dibrugetta | 3200-3500 | Alpine pastures |
| Listera tenuis Lindl. | -do- | Ramni, Deodi | 3500-4000 | Forests |
| Malaxis muscifera | -do- | Dharansi | 3800 | Alpine slopes |
| Neottianthe secundiflora (HK.f.) Schltr. | -do- | Dharansi | 3600 | Alpine slopes |
| Ponerorchis chusua D.Don. | -do- | Dharansi | 3800 | Alpine slopes |
| Dioscorea deltoidea Wall ex Royle | Dioscoreaceae | Beltakharak | 2400-2800 | Forests |
| Allium humile Kunth | Liliaceae | Dibrughetta, Latakharak | 3000-4000 | Alpine pastures |
| A. stracheyi Baker | -do- | Sarsaupatal | 3500-4500 | Alpine pastures |
| Clintonia udensis Taut. & Mey. | -do- | Latakharak | 3000-3600 | Forests |
| Fritillaria roylei D.Don. | -do- | Mall Dibrughetta | 3500-4000 | Alpine pastures |
| Thamnocalamus falconeri HK. f. ex Munro | Poaceae | Chinwari | 2500-3300 | Forests |

**II. Gymnosperms**

| | | | | |
|---|---|---|---|---|
| Ephedra gerardiana Wall. ex. Stapf. | Ephederaceae | Sarsonpatal | 4000-4500 | Alpine slopes |

**III. Pteridophytes**

| | | | | |
|---|---|---|---|---|
| Botrychium lunaria (L.) Sw. | Botrychiaceae | Malla chhinabari, in route to Deodi. | 2700-3700 | Alpine pastures |
| B. ternatum (Thunb.) Sw. | -do- | Chhinabari | 2500 | Forests |
| Ctenopteris subfalcata (Bl.) Kuntz. | Grammitaceae | Chhinabari | 2500 | Moss laiden rocks |
| Coniogramme intermedia Hieron var. glabra-Ching. | Hemionitidaceae | Beltakharak | 2400-2700 | Forests |
| Pteris dactylina HK. | Pteridaceae | Between Kalikora to chhinabari | 2350-2800 | Rock crevices |
| P. excelsa Gaud. | -do- | -do- | 2300-2800 | -do- |
| P. stenophylla Wall ex HK. et Grev. | -do- | Rishi Ganga gordge | 2300-2700 | - do- |
| Asplenium capillipes Makino | Aspleniaceae | Chhinabari, Deodi | 2500-3500 | - do- |
| Cystopteris montana (Lem.) Bernh. ex Desv. | Athyriaceae | Malla Deodi, Bagnidhar | 3500-4000 | Shrubberries, Alpine pastures |
| Gymnocarpium dryopteris (L.) New. | -do- | Dudhganga | 3000-3500 | Forests |

### Table 4. Red Data Book Records

| **Taxa** | **Family** | **Locality** | **Altitudinal range (m)** | **RDB Status** |
|---|---|---|---|---|
| Nardostachys grandiflora DC. | Valerianaceae | Bhujgara | 3500-4200 | Vulnerable |
| Saussurea costus (Falc.) Lipsch. | Asteraceae | Deodi | 3300-3600 | Endangered |
| Picrorhiza kurrooa Royle ex Benth. | Scrophulariaceae | Trishul nullah | 3300-4000 | Vulnerable |
| Cypripedium elegans Reichb. | Orchidaceae | Dharansi | 3400 | Rare |
| Cypripedium himalaicum Rolf. | Orchidaceae | Dibrughetta | 3400 | Rare |
| Dioscorea deltoidea Wall. ex Kunth | Dioscoreaceae | Beltakharak | 2400-2800 | Vulnerable |
| Allium stracheyi Baker | Liliaceae | Sarsaupatal | 3500-4500 | Vulnerable |

## Table 5 NATURAL RESOURCE UTILISATION PATTERN IN LATA, PENG AND RENI VILLAGES OF NANDA DEVI BIOSPHERE RESERVE

| Species Name | Local Name | Part(s) used | Mode of utilisation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Rheum australe | Dolu | a,b | + | + | - | - | - | - | - | - | - |
| R.webbianum | Tatari | b | - | + | - | - | - | - | - | - | - |
| Picrorhiza kurrooa | Katuki | a | + | - | - | - | - | - | - | - | - |
| Dactylorrhiza hatagirea | Hathajari | a | + | - | - | - | - | - | - | - | - |
| Aconitum heterophylum | Atees | a | + | - | - | - | - | - | - | - | - |
| Angelica glauca | Chhippi | a | + | + | - | - | - | - | - | - | - |
| Pleurospermum angelicoides | Choru | a | + | + | - | - | - | - | - | - | - |
| Allium humile | Pharan | b,c | - | + | - | - | - | - | - | - | - |
| A.stracheyi | Jambu | b,c | - | + | - | - | - | - | - | - | - |
| A.wallichii | Pharan | b | - | + | - | - | - | - | - | - | - |
| Podophyllum hexandrum | Gheecharpu | a,d | + | + | - | - | - | - | - | - | - |
| Smilacina purpurea | Puyon | f | - | + | - | - | - | - | - | - | - |
| Megacarpaea polyandra | Barmao | a,b | + | + | - | - | - | - | - | - | - |
| Elaeagnus parvifoli | Gewai | d | - | + | - | - | - | - | - | - | - |
| Arnebia benthamii | Balchhari | a | - | - | - | - | - | - | - | + | - |
| A.euchroma | " | a | - | - | - | - | - | - | - | + | - |
| Jurinea himalaica | Budhkesh | a | - | - | - | - | - | - | - | - | + |
| Nardostachys grandiflora | Mansi | a | - | - | - | - | - | - | - | - | + |
| Skimmia laureola | Nair | b | - | - | - | - | - | - | - | - | + |
| Rhododendron anthopogon | Takkar | b | - | + | - | - | - | - | - | - | + |
| Polygonatum | Salam- | e | - | + | - | - | - | - | - | - | - |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| cirrhifolium | misri | | | | | | | | | | |
| P.verticillatum | " | e | - | + | - | - | - | - | - | - | - |
| Phytolacca acinosa | Jagra | b | - | + | - | - | - | - | - | - | - |
| Chenopodium botrys | Bethu | f | - | + | - | - | - | - | - | - | - |
| C.foliolosum | " | f | - | + | - | - | - | - | - | - | - |
| Fagopyrum debotrys | Kanai | f | - | + | - | - | - | - | - | - | - |
| Taxus baccata | Thuner | j | - | + | - | - | - | - | - | - | - |
| Betula utilis | Bhojpatra | i,k,r | - | + | + | + | - | - | - | + | + |
| Bergenia ligulata | Silphor | a,b | + | + | - | - | - | - | - | - | - |
| B.stracheyi | " | a,b | + | + | - | - | - | - | - | - | - |
| Hippophae rhamnoides | Ameos | d | - | + | - | - | - | - | - | - | - |
| H.salicifolia | " | d | - | + | - | - | - | - | - | - | - |
| Viburnum cotinifolium | Ghenu | d | - | + | - | - | - | - | - | - | - |
| Prunus cornuta | Jamun | d | - | + | - | - | - | - | - | - | - |
| P. persica | Kirol | d | - | + | - | - | - | - | - | - | - |
| Parthenocissus himalayana | Seum | d | - | + | - | - | - | - | - | - | - |
| Ribes himalayense | Darbag | d | - | + | - | - | - | - | - | - | - |
| R.glaciale | " | d | - | + | - | - | - | - | - | - | - |
| Rubus foliolosus | Hisal | d | - | + | - | - | - | - | - | - | - |
| R.niveus | " | d | - | + | - | - | - | - | - | - | - |
| Morchella esculenta | Guchhi | s | - | + | - | - | - | - | - | - | - |
| Jugulans regia | Akhru | g | + | + | - | - | - | - | - | - | - |
| Berberis aristata | Kilmor | d | - | + | - | - | - | - | - | - | - |
| B.lycium | " | d | - | + | - | - | - | - | - | - | - |
| B.pseudumbellata | " | d | - | + | - | - | - | - | - | - | - |
| Saussurea costus | Kut | a | + | - | - | - | - | - | - | - | - |
| S.obvallata | Brahmkamal | h | - | - | - | - | - | - | - | - | + |
| Viola canescens | Banspati | b | + | - | - | - | - | - | - | - | - |
| V.pilosa | " | b | + | - | - | - | - | - | - | - | - |
| Indigofera heterantha | Sagina | b,i,k | - | - | + | + | - | - | - | - | - |
| Cotoneaster affinis | Ruins | b,i,k | - | - | + | + | + | - | - | - | - |
| C.obtusa | Dwis | b,i,k | - | - | + | + | + | - | - | - | - |
| Desmodium elegans | Chamla | b,i,k | - | - | + | + | - | - | - | - | - |
| Morus serrata | Kemu | b,d,i | - | + | + | + | - | - | - | - | - |
| Celtis australis | Kharik | b,i,k | - | - | + | + | - | - | - | - | - |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acer cappadocicum | Kajau | b,i,k | - | - | + | + | - | - | - | - | - |
| Corylus jacquemontii | Kabasi | i,b,g | - | + | + | + | - | - | - | - | - |
| Colquhonia coccinea | Bhekuyi | b,i,k | - | - | + | + | - | - | - | - | - |
| Spirea canescens | Mario | b,i,k | - | - | + | + | - | - | - | - | - |
| Deutzia staminea | Dhanay | b,i,k | - | - | + | + | - | - | - | - | - |
| Quercus floribunda | Telung | b,i,k | - | - | + | + | + | - | - | - | - |
| Toona serrata | Dalla | i | - | - | - | - | + | + | - | - | - |
| Rhus punjabensis | Almor | i | - | - | - | - | - | + | - | - | - |
| Pinus wallichiana | Kail | i,k | - | - | - | + | - | + | - | - | - |
| Picea smithiana | Raga | i,k | - | - | - | + | - | + | - | - | - |
| Arundinaria falcata | Pultar | l | - | - | - | - | - | + | - | + | - |
| Thamnocalamus spathiflora | Tham | l | - | - | - | - | - | + | - | + | - |
| Cannabis sativa | Bhang | i,n | - | - | - | - | - | - | + | - | - |
| Cupressus torulosa | Surai | i,k | - | - | - | + | - | + | - | - | - |
| Selinum tenuifolium | Dhoopkesh | a | - | - | - | - | - | - | - | - | + |
| Cynodon dactylon | Doob | q | - | - | - | - | - | - | - | - | + |
| Artemisia nilgarica | Kunj | k | - | - | - | - | - | - | - | - | + |
| Ajuga parviflora | Titpatti | b | + | - | - | - | - | - | - | - | - |
| Diplazium esculentum | Lingara | m | - | + | - | - | - | - | - | - | - |
| Prinsepia utilis | Bhekuwa | n | - | + | - | - | - | - | - | - | - |
| Fragaria daltoniana | Kume-mati | d | - | + | - | - | - | - | - | - | - |
| F.nubicola | Bhawila | d | - | + | - | - | - | - | - | - | - |
| Rosa macrophylla | Sedum | d | - | + | - | - | - | - | - | - | - |
| R.sericea | " | d | - | + | - | - | - | - | - | - | - |
| R.webbiana | " | d | - | + | - | - | - | - | - | - | - |
| Rumex hastatus | Chalmor | f | - | + | - | - | - | - | - | - | - |
| R.nepalensis | Jangli-palak | b | - | + | - | - | - | - | - | - | - |
| Nepeta discolor | Khirki | k | - | - | - | - | - | - | - | + | - |
| Polygonum recumbens | - | b | + | - | - | - | - | - | - | - | - |
| Chrysopogon gryllus | Khaur | f | - | - | + | - | - | - | - | - | - |
| Gerardenia heterophylla | Kal-bangla | i | - | - | - | - | - | - | + | - | - |
| Abelia triflora | Kamera | b,i,k | - | - | + | - | - | - | - | - | - |
| Dioscorea deltoidea | Manaria | e | + | - | - | - | - | - | - | - | - |
| Ficus palmata | Bedu | d | - | + | - | - | - | - | - | - | - |
| Populus ciliata | Shyan | i | - | - | - | - | + | - | - | - | - |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pyracantha crenulata | Ghingaru | d | - | + | - | - | - | - | - | - | - |
| Tanacetum tometosum | Dhoop | e | - | - | - | - | - | - | - | - | + |
| Juniperus indica | Bhitar | b | - | - | - | - | - | - | - | - | + |
| Origanum vulgare | Bantulsi | b | - | + | - | - | - | - | - | - | - |
| Sedum rosulatum | Arhu | b | + | - | - | - | - | - | - | - | - |
| Melothria heterophylla | Gwalkakari | d | - | + | - | - | - | - | - | - | - |

Key

1 - Medicinal; 2 - Edible; 3 - Fodder; 4 - Fuel; 5 - Cultivated tools; 6 - House building; 7 - Fibres;; 8 - Miscellaneous; 9 - Religious.

a. roots; b. leaves; c. bulb; d.ripe fruits; e.tubers; f.aerial part; g. cotyledon; h flowers; i. stem; j. bark; k.branches; l. culms; m. young fronds; n. seeds; o.ripe figs;
q whole plant; r resin; s fruiting body.

# APPENDEX:1
## Angiosperms

| Botanical Name/ | Locality | Altitudinal range (m) | Life form | | | Habitats |
|---|---|---|---|---|---|---|
| | | | H | Shb | T | |
| **Ranunculaceae** | | | | | | |
| Aconitum balfourii Stapf. | Deodi, Tishul Nullah | 3000 - 4500 | + | - | - | 1,9 |
| A. falconeri Stapf. | Ramni | 3513m | + | - | - | 2 |
| A. heterophyllum Wall. ex Royle | Chhinabari | 2400 - 2700 | + | - | - | 1 |
| A. violacoum Jacg. ex Stapf | Dibrughetta | 3000 - 4000 | + | - | - | 1,3 |
| Aquilegia pubiflora Wall. ex Royle | Beltakharak | 2700 - 3000 | + | - | - | 1 |
| Actaea spicata L. var. acuminata (Wall. ex Royle) Hara | Murana Kalikona | 2200 - 2400 | + | - | - | 1 |
| Anemone obtusiloba D. Don | Dibrughetta | 3300 - 4000 | + | - | - | 9 |
| A. polyanthes D. Don | Bagni Dhar,Malla Deodi, | 3500 - 4000 | + | - | - | 9 |
| A. rupicola Camb. | Ramni | 3500 - 4000 | + | - | - | 2,6 |
| A. vitifolia Buch.-Ham ex DC. | Murana, Kalikona | 2200 - 2500 | + | - | - | 1 |
| A. tetrasepala Royle | Dibrughetta | 3300 - 4000 | + | - | - | 2,9,11 |
| A. rivularis Buch.-Ham. ex DC. | Chhinabari to Dudh Ganga | 2400 - 3000 | + | - | - | 1,3 |
| Clematis barbellata Edgew. | Dibrughetta | 3400 - 4000 | - | + | - | 1 |
| C. montana Buch.-Ham. ex. D. Don | Kalikona | 2200 - 2800 | - | + | - | 1 |
| C. connata DC. | Kakikona | 2380 | - | + | - | 1 |
| Delphinium denudatum Wall. ex HK. & Th. | Kalikona Reni, Murana | 2000 - 3000 | + | - | - | 1,2 |
| D. vestitum Wall. ex Royle | Himtoli | 3300 | + | - | - | 1 |
| D. cashmirianum Royle | Sarsaupatal, Pathalkhan | 4000 - 4500 | + | - | - | 5,11 |
| Callianthemum pimpinelloides (D. Don) H K. f | North Sarsaupatal | 4000 - 4600 Sanctuary, | + | - | - | 6,9 |
| Oxygraphis polypetala Royle Hk. f. & Th. | Pathalkhan, Bhujgara | 3600 - 4[illegible] | + | - | - | 2,6 |
| Paraquilegia microphylla (Royle) Drum & Hutch. | Ranni to Pathalkhan | 3500 - 4200 | + | - | - | 6 |
| P. kareliniana (Drum.) Nevski | Bhujgara to Pathalkhan | 3800 - 4000 | + | - | - | 6 |
| P. anemonoides (Willd.) Ulbr. | Dharansi | 3500 - 4500 | + | - | - | 6 |
| Ranunculus hyrtellus Royle ex D. Don | Sarsaupatal | 3000 - 4500 | + | - | - | 8,9 |
| R. pulchellus Mey. | Sarsaupatal | 4000 - 4500 | + | - | - | 8 |
| R. diffusus DC. | Dibrughetta | 2500 - 3800 | + | - | - | 9 |
| Thalictrum alpinun L. | Sarsaupatal | 3000 - 4500 | + | - | - | 9,11 |
| T. cultratum Wall. | Lata Kharak | 3000 - 4000 | + | - | - | 1 |
| T. elegans Wall. ex Royle | Trishul nullah Sarsaupatal | 3300 - 4200 | + | - | - | 2,9,11 |
| T. pauciflorum Royle | Bhujgara | 3500 - 4000 | + | - | - | 6,9 |
| T. reniforme Wall. | Dibrughetta | 3400 - 4000 | + | - | - | 1,9 |
| T. saniculaeforme DC. | Belta Kharak | 2200 - 2700 | + | - | - | 1 |
| **Paeoniaceae** | | | | | | |
| Paeonia emodi Wall. ex Royle | Kalikona | 2300 - 2700 | + | - | - | 1 |
| **Schisandraceae** | | | | | | |
| Schisandra grandiflora (Wall.)HK.f. | Murana, Chninbari | 2400-2700 | - | + | - | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Lardizabalaceae** | | | | | | |
| Holboelia latifolia Wall. | Kalikona | 2200-2600 | - | + | - | 1 |
| **Circaeasteraceae** | | | | | | |
| Ciraeester agrestis Maxim. | Deodi | 3350 | + | - | - | 7 |
| **Berberidaceae** | | | | | | |
| Berberis edgeworthiana Schneid. | Himtoli | 3000 - 3600 | - | + | - | 1 |
| B. aristata DC. | Murana, Beltakharak | 2200 - 3000 | - | + | - | 1,2 |
| B. petiolaris Wall. ex G. Don | Chhinbari | 2500 - 3000 | - | + | - | 1 |
| B. pseudumbellata Parker | Chhinbari to Dudh Ganga | 2700 - 3500 | - | + | - | 1 |
| B. kumaonensis Schn. | Dibrughetta to Deodi | 3000 - 3500 | - | + | - | 9,11 |
| B. umbellata Wall. ex G. Don | Parkuriadhar | 3000 - 4000 | - | + | - | 9,11 |
| B. lycium Royle | Belta kharak | 2000 - 2500 | - | + | - | 1,2 |
| **Podophyllaceae** | | | | | | |
| Podophyllum hexandrum Wall. ex Royle | Deodi, Dibrughelta | 2800 - 3500 | + | - | - | 1,11 |
| **Papaveraceae** | | | | | | |
| Meconopsis aculeata Royle | Bagnidhar, | 3500 - 4500 | + | - | - | 6 |
| **Fumariaceae** | | | | | | |
| Corydalis casimiriana Duthie &Prain | Deodi to Dibrughelta | 3000 - 4000 | + | - | - | 9,11 |
| C. crithmifolia Royle | Sarsaupatal | 4000 - 4600 | + | - | - | 7,9 |
| C. stracheyi Duthie ex Prain | Dharansi Pass | 3500 - 4500 | + | - | - | 6,7,9 |
| C. thryrsiflora Prain | Bhujgara, Ramni | 4000 - 4700 | + | - | - | 9 |
| C. sikkimensis (Prain) Fedde | Bagnidhar, Ramni | 3500 - 4200 | + | - | - | 9 |
| C. govaniana Wall. | Deodi | 3300 - 4000 | + | - | - | 5,8 |
| **Brassicaceae** | | | | | | |
| Erysimum repandum L. | Sarsaupatal | 4000 - 4600 | + | - | - | 10 |
| Arabidopsis himalaica (Edgew.) Schultz. | en route to Deodi | 3000 - 4000 | + | - | - | 2,9 |
| A. thaliana (L.) Heynh. | Dibrughetta | 3000 - 3600 | + | - | - | 9 |
| Capsella-bursa-postoris (L.) Medik. | Deodi, Trishul nullah | 2500 - 4000 | + | - | - | 3,4,6 |
| Cardamine impatiens L. | Rishi Ganga Gordge | 2300 - 3600 | + | - | - | 3,4,7 |
| Draba gracillima HK.f. & Th. | Sarsaupatal | 3500 - 4000 | + | - | - | 9,10 |
| Megacarpaea polyandra Benth. | Malla Dibrughelta | 3500 - 4000 | + | - | - | 9,11 |
| Thlapsi andersonii (Hk.f. & Th.)Schulz. | Sarsaupatal | 3500 - 4500 | + | - | - | 5,9 |
| T. arvense L. | Sarsaupatal | 3200 - 4200 | + | - | - | 6,10 |
| Rorippa nasurtium aquaticum (L.)Heyek. | Reni | 2100 | + | - | - | 5 |
| **Violaceae** | | | | | | |
| Viola biflora L. | Dibrughetta | 2700 - 4300 | + | - | - | 7,9 |
| V. canescens Wall. | Murana, Kalikona | 2000 - 3500 | + | - | - | 2,3,4,6,7 |
| V. pilosa Bl. | Beltakharak | 2000 - 2600 | + | - | - | 4,5,7 |
| **Polygalaceae** | | | | | | |
| Polygala abyssinica R.Br.ex Fresen | Beltakharak | 2500-3000 | + | - | - | 1 |
| **Caryophyllaceae** | | | | | | |
| Arenaria ciliolata Edgew. & HK.f. | Dharansi | 3000 - 4000 | + | - | - | 9 |
| A. festucoides Benth. | Dibrughetta | 2200 - 4000 | + | - | - | 7 |
| A. musciformis Wall. ex. Edgew. | Sarsaupatal | 3500 - 4700 | + | - | - | 6,7,9,10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Silene gonosperma ssp. himalayensis (Rohrb.) Bocqaet | Sarsaupatal | 3500 - 4500 | + | - | - | 9 |
| S. vulgaris (Moench.) Garcke | Dibrughetta | 3000 - 4000 | + | - | - | 9 |
| S. setisperma Majumdar | Dibrughetta | 3400 - 4000 | + | - | - | 9 |
| Thylacospermum caespitosum (Camb.)Schisch. | Sarsaupatal | 4000-4500 | + | - | - | 9 |
| Stellaria himalayensis Majumdar | Latakharak, Chhinabari | 2400 - 3800 | + | - | - | 1,9 |
| S. monosperma Buch.-Ham. ex D. Don | Latakharak | 2300 - 3500 | + | - | - | 1 |
| S. decumbens Edgew. | Bagnidhar | 3200-4000 | + | - | - | 9 |
| Cerastium cerastioides (L.) Britton | Sarsaupatal | 2000 - 4000 | + | - | - | 4,5,7 |
| **Malvaceae** | | | | | | |
| Malva verticillata L. | Lata | 2000-3000 | + | - | - | 2,12 |
| **Hypericaceae** | | | | | | |
| Hypericum oblongifolium Choisy | Reini to Chhinabari | 2000 - 2600 | - | + | - | 1,6 |
| Hypericum uralum Buch.-Ham. ex D. Don | Beltakharak | 2300 - 2700 | - | + | - | 1,6 |
| **Geraniaceae** | | | | | | |
| Geranium donianum Sweet | Sarsaupatal | 4000 - 4500 | + | - | - | 9,11 |
| G. robertianum L. | Dibrughetta | 3300 - 4000 | + | - | - | 9,11 |
| G. rotundifolium L. | Bagnidhar, Bhujgara | 3500 - 4500 | + | - | - | 7 |
| G. wallichianum D. Don ex Sw. | Latakharak Dibrughatta | 2500 - 4000 | + | - | - | 1,7 |
| G. collinum Steph. ex Willd. | Lata | 2200 - 2500 | + | - | - | 7 |
| G. nepalense Sw. | Lata, Belta-kharak | 2200 - 2800 | + | - | - | 1,3,6 |
| Erodium stephanianum Willd. | Belta Kharak | 2400 - 2800 | + | - | - | 6 |
| **Oxalidaceae** | | | | | | |
| Oxalis corniculata L. | Lata | 2000-2400 | + | - | | - 2,12 |
| **Balsaminaceae** | | | | | | |
| Impatiens sulcata Wall. | Dibrughetta | 3000 - 4000 | + | - | - | 3 |
| I. thomsonii Hk. f. | Beltakharak to Latakharak | 2800 - 3500 | + | - | - | 2 |
| I. scabrida DC. | Lata, Belta-kharak | 2300 - 2800 | + | - | - | 4,5 |
| **Rutaceae** | | | | | | |
| Bauninghausenia albiflora (HK) Reichb. ex Meissn | Chhinabari | 2400-2800 | + | - | - | 1 |
| Skimmia laureola(DC.) Sieb.&Zucc.ex Walp. | Beltakharak | 2800-3200 | - | + | - | 1 |
| **Meliaceae** | | | | | | |
| Toona serrata (Royle) Roem. | Kalikona to Chhinabari | 2200-2700 | - | - | + | 1 |
| **Aquifoliaceae** | | | | | | |
| Ilex dipyrena Wall. | Chhinabari, Murana | 2400-2800 | - | - | + | 1 |
| **Celastraceae** | | | | | | |
| Euonymus fimbriatus Wall. ex Roxb. | Chhinabari to Dudhganga | 2400-3000 | - | - | + | 1 |
| **Rhamnaceae** | | | | | | |
| Rhamnus purpureus Edgew. | Kalikona to Chhinabari | 2100 - 2500 | - | + | - | 1 |
| R. virgatus Roxb. | Chhinabari, | 2400-3000 | - | + | - | 1 |
| **Vitaceae** | | | | | | |
| Parthenocissus himalayana (Royle) Planch. | Dibrughetta, Deodi | 2200 - 3500 | - | + | - | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Aceraceae | | | | | | |
| Acer acuminatum Wall. ex. D. Don | Chhinabari | 2490 - 3500 | - | - | + | 1 |
| A. cappadocicum Gled. | Murana | 2100 - 2600 | - | - | + | 1 |
| A. sterculiaceum Wall. | Murana, Kalikona to Chhinabari | 2300 - 2600 | - | - | + | 1 |
| A. caesium Wall. ex Brand. | Chhinabari | 2490 - 3000 | - | - | + | 1 |
| **Hippocastanaceae** | | | | | | |
| Aesculus indica(Colebr.ex Camb.)Hk. | Murana | 2200-2500 | - | - | + | 1 |
| **Sabiaceae** | | | | | | |
| Meliosma dilleniaefolia (Wall.ex Wt.&Arn.)Walp. | Latakharak, Chhinabari | 2300-2800 | - | - | + | 1 |
| **Anacardiaceae** | | | | | | |
| Rhus punjabensis Stewart | Kalikona | 2200 - 2500 | - | - | + | 1 |
| **Coriariaceae** | | | | | | |
| Coriaria nepalensis Wall. | Muranda | 2000 - 2600 | - | - | + | 1,4,5 |
| **Fabaceae** | | | | | | |
| Astragalus chlorostachys Lindl. | Dibrughetta, Deodi | 2500 - 4000 | - | + | - | 1,2,9 |
| A. himalayanus Koltz. | Bhujgara, Deodi | 2800 - 4000 | + | - | - | 9,11 |
| A. candolleanus Royle ex Benth. | Deodi, North Sanctuary | 3300- 4200 | - | + | - | 9,11 |
| A. rhizanthus Royle ex Benth | Bagridhar, Ramni | 3000 - 4000 | + | - | - | 9,11 |
| Desmodium elegans DC. | Chhinabari to Dibrughetta | 2000 - 3000 | - | + | - | 1 |
| Piptanthus nepalensis (HK.) D. Don | Chhinabari | 2400 - 3600 | - | + | - | 1,11 |
| Thermopsis barbata Royle | Dibrughetta to Deodi | 3300 - 4000 | + | - | - | 9 |
| Trigonella emodi Benth. | Beltakharak to Latakharak | 2500 - 3000 | + | - | - | 2,12 |
| Indigofera hebepetala Benth. ex Baker | Pangrani | 2500 - 3000 | - | + | - | 1 |
| I. heterantha Wall. ex Brand. | Kalikona to Chhinabari | 2300 - 2800 | - | + | - | 1,2 |
| Caragana nubigena Bunge | Sarsaupatal, North Sanctuary | 3500 - 4500 | - | + | - | 9,11 |
| C. versicolor (Wall.) Benth. | Lata, Beltakharak | 2200 - 3000 | - | + | - | 2 |
| Lotus corniculatus L. | Dibrughetta | 3400 - 4000 | + | - | - | 9 |
| Parochetus communis Buch.-Ham. ex D. Don | Reni | 2100 - 2800 | + | - | - | 3,5 |
| Hedysarum kumaonense Benth. ex Baker | Sarsaupatal | 4000 - 5000 | + | - | - | 9,10 |
| H. sikkimense Benth. ex Baker | North Sanctuary | 4000 - 5000 | + | - | - | 9,10 |
| Oxytropis microphylla (Pallas) DC. | North Sanctuary | 4000 - 4500 | + | - | - | 10 |
| O. mollis Royle | Sarsaupatal | 4000 - 4700 | + | - | - | 9,10 |
| O. lapponica (Wall.) Gay | Sarsaupatal | 4000 - 4500 | + | - | - | 9,10 |
| **Rosaceae** | | | | | | |
| Cotoneaster obtusa Wall. ex Lindl. | Chhinabari, Kalikona | 2200 - 2800 | - | + | - | 1,2 |
| C. microphylla Wall. ex Lindl. | Dibrughetta | 2450 - 4000 | - | + | - | 2,9,11 |

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|---|---|---|---|---|---|---|
| C. integrifolius (Roxb.) Koltz. | Malla Deodi | 3300 - 3800 | - | + | - | 9,11 |
| C. affinis Lindl. | Latakharak<br>Beltakharak | 2500 - 3300 | - | + | - | 1 |
| C. disticha Lange | Malla Deodi | 3500 - 4000 | - | + | - | 9,11 |
| C. lindleyi steud. | Himtoli | 2500 - 3500 | - | + | - | 1 |
| Fragaria nubicola Lindl. ex Lacaita | Dibrughetta | 2500 - 3500 | + | - | - | 1,3,5,9 |
| F. daltoniana Gay | Dibrughetta to Dharansi | 2800 - 3500 | - | + | - | 9 |
| Potentilla argyrophylla Wall. ex Lehm. | Sarsaupatal | 3000 - 4200 | + | - | - | 9,10 |
| P. atrosanguinea Lodd. | Dibrughetta | 3000 - 4500 | + | - | - | 9,10 |
| P. cuneata Wall. ex Lehm. | Bhujgara | 3000 - 4500 | + | - | - | 9,10 |
| P. eriocarpa Wall. ex Lehm. | Bagnidhar, Ramni | 3500 - 4500 | - | + | - | 9,11 |
| P. fructicosa L. var. rigida | Sarsaupatal | 3500 - 4500 | - | + | - | 5,9,11 |
| P. microphylla D. Don | Dharansi | 3500 - 4500 | + | - | - | 9 |
| P. gelida Mey. | Pathalkhan | 3500 - 4200 | + | - | - | 6,7 |
| P. peduncularis D. Don | Dharansi | 3800 - 4500 | - | + | - | 9 |
| Rosa macrophylla Lindl. | Dibrughetta | 2500 - 4000 | - | + | - | 1,2,11 |
| R. sericea Lindl. | Deodi | 2500 - 3500 | - | + | - | 1,11 |
| R. webbiana Wall. ex Royle | Malla Deodi | 3000 - 4000 | - | + | - | 1,11 |
| Rubus foliolosus D. Don | Dibrughetta | 2000 - 2500 | - | + | - | 1,3 |
| R.biflora Buch.-Ham.ex Sm. | Chhinabari | 2200-2700 | - | + | - | 1 |
| R. niveus Thunb. | Latakharak | 2500 - 3600 | - | + | - | 1 |
| Pyrus pashia Buch.-Ham. ex D. Don. | Lata to Beltakharak | 2400 - 2700 | - | - | + | 1 |
| P. lanata D. Don | Malla Chhinabari | 2800 | - | - | + | 1 |
| Arunchus dioicus (Walt.) Fernald | Malla Chhinabari | 2700 - 4000 | + | - | - | 1,11 |
| Sibbaldia purpurea Royle | Dharansi | 4000 - 4500 | + | - | - | 7,9 |
| S. tetrandra Bunge | Bhujgara, Pathalkhan | 3500 - 4200 | + | - | - | 9,10,11 |
| Sorbus foliolosa (Wall.) Spach. | Dibrughetta, Deodi | 3000 - 4000 | - | + | - | 1 |
| Sorbus microphylla Wenzig | Deodi | 3500-4000 | - | + | - | 1 |
| Sorbaria tomentosa(Lindl.) | Kalikona<br>Rehdr. | 2200-3500 | - | + | - | 1 |
| Spiraea bella Sims. | Latakharak | 3000 - 3600 | - | + | - | 1 |
| S. canescens D. Don | Chhinabari | 2590 - 3000 | - | + | - | 1,2 |
| Pyracantha cranulata (Don) Roem. | Chhinabari | 2400 - 2600 | - | + | - | 1,2 |
| Prunus cornuta (Wall. ex Royle) Steud. | Chhinabari, Latakharak | 2490 - 3500 | - | - | + | 1 |
| P. persica (L.) Botsch | Lata | 2400 - 2600 | - | - | + | 1 |
| Agrimonia pilosa Ledeb. | Chhinabari | 2400 - 2800 | + | - | - | 1,12 |
| Geum roylei Bolle | Dibrughetta | 3000 - 4000 | + | - | - | 9 |
| Filipendula vestita (Wall. ex G. Don) Maxim | Dibrughetta | 3000 - 4000 | + | - | - | 9 |
| Prinsepia utilis Royle | Beltakharak | 2200 - 2800 | - | + | - | 1,2 |
| **Saxifragaceae** | | | | | | |
| Bergenia stracheyi (Hk.f.) Th. | Sarsaupatal | 3500 - 4500 | + | - | - | 6,7 |
| B. ligulata (Wall.) Engl. | Kalikona | 2500 - 3500 | + | - | - | 6,7 |
| Saxifraga asarifolia Sternb. | Bhujgara | 3000 - 4500 | + | - | - | 6,7 |
| S. brachypoda D. Don var. frimbriata (DC.) Engl. | Malla Dibrughetta | 3300 - 4200 | + | - | - | 6,9 |

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|---|---|---|---|---|---|---|
| S. brunonis Wall. ex Seringe | en noute to Ramni | 3400 - 4600 | + | - | - | 6,10 |
| S. diversifolia Wall. ex Ser. | en route to Deodi | 2500 - 4000 | + | - | - | 6 |
| S. filicaulis Wall. ex Ser. | Bagnidhar, Ramni | 3000 - 3800 | + | - | - | 6 |
| S. grandulifora Sm. | Dibrughetta | 3500 - 4500 | + | - | - | 6 |
| S. saginoides HK.f. & Th. | Dharansi | 4000 - 4500 | + | - | - | 6 |
| S.pulvinaria Sm. | NorthSanctuary | 3500-4700 | + | - | - | 6,10 |
| S.sibirica L. | Sarsaupatal | 4000-4500 | + | - | - | 5 |
| S.jacquemontiana Decne | Sarsaupatal | 3000-4500 | + | - | - | 6,10 |
| S.hemisphaerica HK.f.& Th. | Sarsaupatal | 4200-4700 | + | - | - | 6,10 |
| S.andersonii Engl. | en route to Pathalkhan | 3500-4000 | + | - | - | 6 |
| Astilbe rivularis Buch.-Ham. ex D. Don. | Kalikona, Chhinabari | 2200 - 2600 | + | - | - | 1,3 |
| **Parnassiaceae** | | | | | | |
| Parnassia nubicola Wall. ex Royle | Dibrughetta | 3000 - 4000 | + | - | - | 9 |
| Grossulariaceae | | | | | | |
| Ribes himalense Royle ex D. Don. | Dibrughetta | 3000 - 3800 | - | + | - | 1 |
| R. orintale Desf. | Latakharak | 2600 - 3200 | - | + | - | 1 |
| R. glaciale Wall. | Chhinabari | 2500 - 3500 | - | + | - | 1 |
| R. griffithii HK.f. & Th. | Deodi | 3000 - 3500 | - | + | - | 1 |
| R. alpestre Wall. ex. D.Don. | Himtoli | 2600 - 3000 | - | + | - | 1 |
| **Hydrangeaceae** | | | | | | |
| Deutzia compacta Craib | Chhinabari | 2400 - 3000 | - | + | - | 1 |
| D. staminea R. Br.ex Wall. | Kalikona | 2000 - 2600 | - | + | - | 1 |
| Philadelphus tomentosus Wall. ex G. Don. | Dudhganga | 2000 - 3500 | - | + | - | 1 |
| **Crassulaceae** | | | | | | |
| Rhodiola crenulata HK.f & Th. | Dharansi | 3500 - 4200 | + | - | - | 9,10,11 |
| R. heterodonta (Hk.f. & Th.) Boriss. | Deodi, Trishal Nullah | 3000 - 4200 | + | - | - | 9,10,11 |
| R. guadrifida (Pallas) Fisch. & Mey | Bhujgara, Patalkhan | 3000 - 4000 | + | - | - | 6,9,11 |
| R. sinscuata (Royle ex. Bdgew.) Fu | Parkhuriadhar | 3500 - 4000 | + | - | - | 6,9,11 |
| R. wallichiana (Hk.f ) Fu | en route to Deodi | 3000 - 4000 | + | - | - | 1 |
| R. bupleuroides Wall. ex Hk. f. & Th. | Dibrughetta | 3000 - 4000 | + | - | - | 6,9 |
| Rosularia rosulata(Edgew.)Ohba | Beltakharak | 2200-3200 | + | - | - | 1,6,9 |
| Sedum multicaule Wall. ex. Lindl. | Dharansi | 3200 - 4200 | + | - | - | 3,7 |
| S. trullipetalum Hk. f. & Th. | Trishul Nullah, Deodi | 3000 - 3600 | + | - | - | 1,7,9 |
| S. ewersii Ledeb. | Malla Deodi | 3000 - 4000 | + | - | - | 7,9 |
| S. rosulatum Edgew. | Lata | 2200 - 3800 | + | - | - | 7,9 |
| **Onagraceae** | | | | | | |
| Circaea alpina L. | Latakharak, Deodi | 2500 - 3500 | + | - | - | 3,7 |
| Epilobium latifolium L. | Trishul Nullah | 3300 - 4500 | + | - | - | 4,5,11 |
| E. roseum (Schreb.) Pers. | Sarsaupatal, Dharansi | 3500 - 4500 | + | - | - | 9,10 |

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|---|---|---|---|---|---|---|
| Oenothera rosea Ait. | Lata | 2000 - 2500 | + | - | - | 2 |
| **Cucurbitaceae** | | | | | | |
| Melothria heterophylia(Lour.) | Lata Cogn. | 2200-2500 | + | - | - | 1,2 |
| **Apiaceae** | | | | | | |
| Acronema tenera (DC.) Edgew. | Ramni, Bhujgara | 3300 - 4 [illegible] | + | - | - | 1,6,7 |
| Bunium persicum (Boiss.) Fedts. | en route to Ramani | 3000 - 3600 | + | - | - | 1,3 |
| Bupleurum marginatum Wall. ex DC. | Malla Deodi, Latakharak | 3000 - 4000 | + | - | - | 9,11 |
| B.falcatum L. | Dharansi | 3500-4500 | + | - | - | 9,11 |
| B. lanceolatum Wall. ex DC. | Chhinabari | 2200 - 3000 | + | - | - | 1 |
| Heracleum candicans Wall.exDC. | Kalikona to Chhinabari | 2870 - 2500 | + | - | - | 1,2 |
| Chaerophyllum reflexum Lindl. | en route to Latakharak | 2300 - 3000 | + | - | - | 1,3,7,12 |
| Cortia depressa (Don) | Dharansi Norman | 3500 - 4600 | + | - | - | 9,11 |
| Chamaesciadium garhwalicum Wolff.) Norman | Dharansi | 3500 - 4500 | + | - | - | 9 |
| Eriocycla thomsonii Clarke) Wolff. | Sarsaupatal | 3200 - 4200 | + | - | - | 9 |
| Angelica glauca Edgew. | Trishulnullah | 3200-4000 | + | - | - | 1 |
| Trachydium roylei Lindl. | Latakharak | 3500-4000 | + | - | - | 9 |
| Pleurospermum angelicoides (DC.) Clarke) | Dibrugheta | 2800 - 3500 | + | - | - | 1 |
| P. densiflorum (Lindl.) Clarke | Dharansi | 3500 - 4000 | + | - | - | 9 |
| P. stylosum Clarke | Himtoli | 3000 - 4000 | + | - | - | 1,3 |
| Selinum candollei DC. | Trishul Nullah, Deodi | 3000 - 3800 | + | - | - | 1,4 |
| S. elatum (Edgew.) Hiroe | Dibrughetta | 3000 - 3500 | + | - | - | 4,5,9,11 |
| S. vaginatum Clarke | Latakharak, Himtoli | 3000 - 4000 | + | - | - | 1,3 |
| Seseli sibiricum (L.) Boiss. | Himtoli | 3000 - 3500 | + | - | - | 1,9,11 |
| Pimpinella acuminata (Edgew.) Cl. | Chhinabari | 2500 - 3000 | + | - | - | 1 |
| P. diversifolia DC. | Dibrughetta | 2400 - 3000 | + | - | - | 1 |
| Cortiella hookeri(Cl.)Norm. | Sarsaupatal | 4200-4500 | + | - | - | 9 |
| **Araliaceae** | | | | | | |
| Acanthopanax cissifolius (Girff. ex seem.) Harms. | Chhinabari Dibrughetta | 2500 - 3500 | - | + | - | 1 |
| Hedera nepalensis Koch. | Dibrughetta | 2300 - 3500 | - | + | - | 1 |
| **Cornaceae** | | | | | | |
| Cornus macrophylla Wall. | Chhinabari | 2200 - 2600 | - | - | + | 1 |
| **Caprifoliaceae** | | | | | | |
| Abelia triflora R. Br. ex Wall. | Beltakharak to Latakharak | 2300 - 2800 | - | + | - | 1 |
| Leycesteria formosa Wall. | Kalikona, Chhinabari | 2370 - 2700 | - | + | - | 1,3,5 |
| Lonicera obovata Royle ex Hk. f. & Th. | Sarsaupatal | 3500 - 4500 | - | + | - | 9,11 |
| L. spinosa (Jacq. ex Decne.) Walp. | Sarsaupatal | 3500 - 4500 | - | + | - | 9,11 |
| L. webbiana Wall. ex DC. | Dibrughetta | 3000 - 3600 | - | + | - | 1 |
| L.angustifolia Wall.ex DC. | Dibrughetta | 3500-4000 | - | + | - | 1 |
| L.asperifolia(Decne)HK.f.&Th. | North Sanctuary | 4100 | - | + | - | 4,10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| L. quinqulocularis Hardw. | Kalikona, Chhinabari | 2300 - 3000 | - | + | - | 1,2 |
| Triosteum himalayanum Wall. | Beltakharak | 2500 - 2800 | + | - | - | 1 |
| Vibrunum cotinifolium D.Don. | Dibrughetta | 2300 - 3000 | - | + | - | 1 |
| V. grandiflorum Wall.ex DC. | Dibrughetta | 3000 - 3500 | - | + | - | 1 |
| V. erubescens Wall. ex DC. | Dibrughetta | 2700 - 3600 | - | + | - | 1,11 |
| V. mullah Buch.-Ham. ex. D. Don. | Chhinabari | 2400 - 2600 | - | + | - | 1 |
| **Rubiaceae** | | | | | | |
| Galium acutum Edgew. | Dibrughetta | 2500 - 4000 | + | - | - | 3,7,9 |
| G. aparine L. | Deodi | 2700 - 4000 | + | - | - | 1,7 |
| Rubia manjith Roxb. ex Flem. | Kalikona to Dudhganga | 2300 - 3000 | - | + | - | 1 |
| Leptodermis kumaonensis Parker | en route to Deodi | 2700 - 3500 | + | - | - | 2,7 |
| **Valerianaceae** | | | | | | |
| Nardostachys grandiflora DC. | Bhujgara, Dharansi | 3500 - 4200 | + | - | - | 6,7 |
| V. hardwickii Wall. | Dibrughetta | 2200 - 4000 | + | - | - | 1,3,9 |
| V. dioica L. | Dharansi | 3500 - 4000 | + | - | - | 9 |
| **Dipsacaceae** | | | | | | |
| Morina longifolia Wall. ex DC. | Dibrughetta | 3000 - 4000 | + | - | - | 9 |
| Dipsacus inermis Wall. | Chhinabari | 2300 - 2800 | + | - | - | 1 |
| **Asteraceae** | | | | | | |
| Anaphalis contorta (D.Don) HK. f. | Dibrughetta | 2400 - 3500 | + | - | - | 1,2,6 |
| A. nepalensis (Spreng.) Hand.- Mazz. | Dharansi | 2700 - 4000 | + | - | - | 2,9 |
| A. royleana DC. | Malla Deodi | 3200 - 4000 | + | - | - | 1,9,11 |
| A. triplineris (Sims.) Clarke | Dudhganga | 2300 - 3000 | + | - | - | 1,6 |
| Siegesbeckia orientalis L. | Reni to Lata | 2000 - 2300 | + | - | - | 1,12 |
| Artemisia maritima L. | Sarsaupatal | 3500 - 4500 | + | - | - | 9,11 |
| A. nilagarica (Cl.) Pamp. | Lata | 2000 - 2700 | + | - | - | 2 |
| A. roxburghiana Wall. ex Besser var. grata (Wall.) Hk. f. | Between Deodi & Dibrughetta | 2000 - 2500 | + | - | - | 2 |
| A. capillaris Thunb. | Reni, Lata | 2000 - 2500 | + | - | - | 2,12 |
| A. japonica Thunb. | Lata | 2000 - 2500 | + | - | - | 2,12 |
| Aster diplostephioides (DC.) Clarke | Dibrughetta | 3000 - 4000 | + | - | - | 9,11 |
| Cirsium wallichii DC. | Dibrughetta | 2500 - 3500 | + | - | - | 3,5,9 |
| Cremanthodium arnecoides (Wall. ex DC.) Good | Ramni | 2700 - 4000 | + | - | - | 1,3 |
| Dubyaea hispida (D.Don) DC. | Dharansi | 3300 - 4000 | + | - | - | 9,11 |
| Erigeron multiradiatus (DC.) Benth. | Malla Dibrughetta | 3000 - 4000 | + | - | - | 9,11 |
| Echinops cornigerus DC. | Reni | 2000 - 2200 | + | - | - | 2 |
| Inula cuspidata (DC.) Clarke | Dibrughetta | 2700 - 3800 | + | - | - | 1,11 |
| Sonchus oleraceus L. | Lata to Beltakharak | 2000 - 2600 | + | - | - | 1,12 |
| Ainsliaea aptera DC. | Deodi | 2400 - 3500 | + | - | - | 1 |
| Jurinea himalaica Stewart | Dharansi | 3500 - 4500 | + | - | - | 9 |
| Gnaphalium affine D.Don | Lata | 2000 - 2400 | + | - | - | 2 |
| Lactuca lessertiana (Wall. ex DC.) Cl. ssp. dentata Stebbins | Ramni | 3200 - 4000 | + | - | - | 3,7 |
| L. macrorhiza (Royle) HK. f. | Dibrughetta | 3000 - 4000 | + | - | - | 9 |
| L. violaefolia (Decne) Cl. | Latakharak, Dibrughetta | 3000 - 4000 | + | - | - | 3,9 |
| Waldheimia tomentosa (Decne) Royle | Sarsaupatal | 4000 - 4700 | + | - | - | 10,11 |
| Leontopodium himalayanum DC. | Dibrughetta | 3000 - 4500 | + | - | - | 9,11 |
| Myriactis nepalensis Less. | Chhinabari | 2300 - 2700 | + | - | - | 1 |

| Botanical Name/ | Locality | Altitudinal range (m) | Habitats | | | Life form H Sub T |
|---|---|---|---|---|---|---|
| Ligularia sibirica (L.f.) Cass. | Dibrughetta | 3000 - 3600 | + | - | - | 3,9 |
| Saussurea obvallata (DC.) Sch.- Bip. | Dibrughetta | 3500 - 4500 | + | - | - | 9,11 |
| S.leontodontoides(DC.)Sch.- Bip. | Sarsaupatal | 3500-4500 | + | - | - | 9 |
| S. costus (Falc.) Lipsch. | Deodi | 3300 - 4000 | + | - | - | 1 |
| Senecio alatus Wall. ex DC. | Latakharak | 3500 - 4000 | + | - | - | 9,11 |
| S. chrysanthemoides DC. | Latakharak | 2700 - 3800 | + | - | - | 1 |
| S. graciliflorus DC. | Dibrughetta | 3300 - 4000 | + | - | - | 9 |
| S. kunthianus Wall. ex DC. | Bhujgara | 3000 - 4000 | + | - | - | 1,11 |
| S. quinquelobus HK.f. & Th. | Himtoli | 2700 - 3600 | + | - | - | 1,3 |
| Tagetes minuta L. | Lata | 2200 - 2500 | + | - | - | 2 |
| Solidago virga-aurea L. | Dibrughetta | 2500 - 3500 | + | - | - | 1 |
| Tanacetum tomentosum DC. | Sarsaupatal | 3500 - 4500 | + | - | - | 9,10 |
| Taraxacum officinale Webar | Dibrughetta | 2200 - 4000 | + | - | - | 3,9 |
| Conyza stricta Willd. | Reni,Lata | 2000 -2500 | + | - | - | 2 |
| C.bonariensis(L.)Conq. | Lata | 2200-2500 | + | - | - | 2 |
| Campanula colorata Wall. | Beltakharak to Latakharak | 2200-3000 | + | - | - | 6,7 |
| **Campanulaceae** | | | | | | |
| Codonopsis rotundifolia Benth. | Dibrughetta | 2500-3500 | + | - | - | 1 |
| Cynanthus lobatus Wall. ex Benth. | Dibrughetta | 3000-4000 | + | - | - | 7,9 |
| C.microphyllus Edgew. | Deodi | 3000-4000 | + | - | - | 9 |
| **Ericaceae** | | | | | | |
| Cassiope fastigiata(Wall). D.Don | Sarsaupatal | 3000-4000 | - | + | - | 9,11 |
| Gaultheria trichophylla Royle | Deodi | 3000-4000 | + | - | - | 1,9 |
| Rhododendron anthopogon D.Don | Dibrughetta | 3000-4500 | - | + | - | 1,9,11 |
| R. arboreum Sm. | Chhinabari | 2200-3000 | - | - | + | 1 |
| R.campanulatum D.Don | Dibrughetta | 2800-4000 | - | + | - | 1,11 |
| R. lepidotum Wall.ex D.Don | Latakharak | 2800-4000 | - | + | - | 1,9,11 |
| Monotropaceae | | | | | | |
| Monotropa hypopitys L. | Beltakharak | 2600 | + | - | - | 1 |
| **Primulaceae** | | | | | | |
| Androsace globifera Duby | Sarsaupatal | 35004500 | + | - | - | 10 |
| A.sarmentosa Wall. | Dibrughetta | 3000-4000 | + | - | - | 9 |
| Lysimachia lobelioides Wall. | Reni | 2000 | + | - | - | 3 |
| Primula denticulata Sm. | Deodi | 2800-4200 | + | - | - | 2,9,11,12 |
| P.macrophylla D.Don var. moorcroftiana (Wall) Pax | Sarsaupatal | 3500-4600 | + | - | - | 3,8,9 |
| P.minutissima Jacq.ex Duby | Sarsaupatal | 4000-4600 | + | - | - | 9,11 |
| P. munroi Lindl. | Sarsaupatal | 4000-4500 | + | - | - | 9 |
| P.reptans HK.f.ex Watt | North Sanctuary | 4000-4500 | + | - | - | 9 |
| P.glomereta Pax | Sarsaupatal | 3000-4600 | + | - | - | 1,9 |
| P. involucrata Wall.ex Duby | Sarsaupatal | 4000-4200 | + | - | - | 5,8 |
| P. atrodentata Sm. | Sarsaupatal | 3500-4500 | + | - | - | 9,11 |
| P. elliptica Royle | North Sanctuary | 3500-4500 | + | - | - | 9 |
| **Oleaceae** | | | | | | |
| Jusminum humile L. | Deodi | 2500-3500 | - | + | - | 1,11 |
| J.Officinale L. | Kalikona | 2350 | - | + | - | 3 |
| Syringa emodi Wall. ex Royle | Dibrughetta | 3000-4000 | - | - | + | 1 |
| **Asclepiadaceae** | | | | | | |
| Cynanchum canescens (Willd.) Schum | Chhinabari, en route to Deodi | 2490-3600 | - | + | - | 1,2,9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Marsdenia roylei Wt. | Beltakharak | 2500-2800 | - | + | - | 1 |
| Loganiaceae | | | | | | |
| Buddleja crispa Benth. | Beltakharak, Lata. | 2000-2500 | - | + | - | 1,6 |
| **Gentianaceae** | | | | | | |
| Gentiana argentea (D.Don) Cl. | Dibrughetta | 3000-4000 | + | - | - | 5,8,9,11 |
| G. capitata Buch-Ham. ex D.Don | Dharansi | 3500-4500 | + | - | - | 7,9 |
| G. venusta (G.Don) Griseb. | Dharansi | 3000-4000 | + | - | - | 3,9 |
| G.carinata Griseb. | Malla Dibrughetta | 3000-4000 | + | - | - | 9 |
| Gentianella pedunculata (D.Don) Sm. | en route to Bhujgara | 3500-4000 | + | - | - | 9 |
| Halenia elliptica D.Don | Dharansi | 3000-4000 | + | - | - | 9,11 |
| Lomatogonium carinthiacum (Wolf)A.Br. | Pathalkhan | 3500-4000 | + | - | - | 9 |
| Swertia ciliata (G.Don) Burtt. | Dibrughetta | 3400-4000 | + | - | - | 9,11 |
| S.cuneata Wall. ex D.Don | Dharansi | 3500-4500 | + | - | - | 9,11 |
| **Boraginaceae** | | | | | | |
| Arnebia benthamii (Wall ex G.Don) John. | Dibrughetta | 3300-3800 | + | - | - | 9,11 |
| A. euchroma (Royle) John. | Sarsaupatal | 4000-4500 | + | - | - | 9 |
| Hackelia uncinata (Royle ex Benth.) Fisch. | Chhinabari | 2400-3800 | + | - | - | 1,3,12 |
| Myosotis syvatica Ehrh. ex Hoffm. | Dibrughetta | 3000-4000 | + | - | - | 2 |
| Cynoglossum zeylanicum (Vahl) Thumb ex Lehm. | Lata | 2000-2500 | + | - | - | 2,12 |
| Eritrichum canum (Benth) Kitamura | Dharansi | 3500-4000 | + | - | - | 9 |
| **Cuscutaceae** | | | | | | |
| Cuscuta europea L. | Dibrughetta | 3500 | + | - | - | 15 |
| C.reflexa Roxb. | Kalikona,Lata | 2300-2500 | + | - | - | 15 |
| **Convolvulaceae** | | | | | | |
| Convolvulus arvensis L. | Lata | 2200-2500 | + | - | - | 2 |
| **Solanaceae** | | | | | | |
| Datura stramonium L. | Murana, Lata | 2000-2400 | + | - | - | 3,12 |
| Solanum nigrum L. | Lata | 2000-2600 | + | - | - | 4,5 |
| **Scrophulariaceae** | | | | | | |
| Euphrasia kurramensis Pennell | Dibrughetta | 3000-4000 | + | - | - | 9 |
| Picrohiza kurrooa Royle ex Benth | Dharansi, Trishul nullah | 3500-4500 | + | - | - | 2,9 |
| Scrophularia calycina Benth. | Latakharak | 2300-2800 | + | - | - | 6,7 |
| S. himalensis Royle exBenth. | Dibrughetta | 2500-3200 | + | - | - | 1,6,7 |
| Verbascum thapsus L. | Dibrughetta | 2000-4000 | + | - | - | 1,9,11 |
| Veronica capitata Benth. | Sarsaupatal | 4000-4700 | + | - | - | 9,10 |
| V. lanosa Royle ex Benth. | Sarsaupatal | 4000-4700 | + | - | - | 9,10 |
| Hemiphragma heterophyllum Wall. | Dibrughetta | 2500-3500 | + | - | - | 1,3 |
| Mazus pumilus (Burm.f.) Steen | Beltakharak | 2000-2800 | + | - | - | 3 |
| Pedicularis bicornuta Klotz. | Dibrughetta | 3400-4000 | + | - | - | 9 |
| P.hoffmeisteri Klotz. & Garcke. | Sarsaupatal | 3500-4500 | + | - | - | 9,11 |
| **Orobanchaceae** | | | | | | |
| Orobanche alba Steph.ex willd. | Murana, Chhinabari | 2500-3200 | + | - | - | 15 |
| Boschniakia himalaica HK.&Th.ex HK.f. | Deodi | 2800-3800 | + | - | - | 15 |
| **Lentibulariaceae** | | | | | | |
| Pinguicula alpina L. | Pathalkhan | 3800 | + | - | - | 3 |
| **Bignoniaceae** | | | | | | |
| Incarvillea arguta (Royle) Royle | Kalikona | 2000-2300 | - | + | - | 6 |
| **Acanthaceae** | | | | | | |
| Dicliptera bupleuroides Nees | Lata,Reni | 2000-2400 | + | - | - | 2,7 |
| Goldfussia dalhousiana Nees | Beltakharak | 2400-2800 | + | - | - | 1 |
| Strobilanthes atropurpureus Nees | Dibrughetta | 2800-3500 | + | - | - | 1 |
| S. wallichii Nees | Deodi | 3000-4000 | + | - | - | 1 |

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|---|---|---|---|---|---|---|
| **Lamiaceae** | | | | | | |
| Ajuga parviflora Benth. | Deodi | 2000-3500 | + | - | - | 1 |
| Clinopodium vulgare L. | Dibrughetta | 2400-3800 | + | - | - | 3 |
| Elshoultzia eriostachya Benth. | Malla Deodi | 3000-4000 | + | - | - | 9,11 |
| E.strobilifera (Benth). Benth | Kalikona | 2200-2500 | + | - | - | 3,5,7 |
| E.fruticosa (D.Don) Rehder | Deodi | 3000-4000 | + | - | - | 3,,9 |
| Nepeta discolor Royle ex Benth | Lata | 2300-2800 | - | + | - | 2 |
| Leucas lanata Benth. | Kalikona | 2000-2500 | + | - | - | 6,7 |
| Micromeria biflora (Buch-Ham.ex D.Don)Benth | Beltakharak | 2000-2800 | + | - | - | 2,7 |
| Origanum vulgare L. | Dibrughetta | 2000-3500 | + | - | - | 1,3,9 |
| Phlomis bractosa Royle ex Benth. | Latakharak | 2800-3800 | + | - | - | 9 |
| Thymus linearis benth. | Sarsaupatal | 2300-4000 | + | - | - | 2,9 |
| Colquhonia coccinea Wall | Lata | 2000-2200 | - | + | - | 2 |
| Craniotome furcata (Link.) Kuntz | Latakharak | 2300-2600 | + | - | - | 2,12 |
| Scutellaria scandens Buch-Ham.ex D.Don | Lata | 2000-2600 | + | - | - | 2,7 |
| Stachys sericea Wall ex Benth | Beltakharak | 2300-2800 | + | - | - | 1,2 |
| **Plantaginaceae** | | | | | | |
| Plantago himalaica Pilger | Lata | 2600-3200 | + | - | - | 3,5,8 |
| Nyctaginaceae | | | | | | |
| Boerhaavia diffusa L. | Reni,Lata | 2000-2400 | + | - | - | 2 |
| Amarantaceae | | | | | | |
| Cyathula tomentosa(Roth) Moq. | Lata | 2000-2500 | + | - | - | 2 |
| Chenopodiaceae | | | | | | |
| Chenopodium botrys L. | Latakharak | 2000-3800 | + | - | - | 2,3,9 |
| C.foliolossum(Moench.) Asher. | Dibrughetta | 3000-4000 | + | - | - | 3,9 |
| Phytolaccaceae | | | | | | |
| Phytolacca acinosa Roxb. | Lata,Beltakharak | 2300-2700 | + | - | - | 1,6 |
| Polygonaceae | | | | | | |
| Fagopyrum debotrys(D.Don) Home. | Dibrughetta | 2000-3500 | + | - | - | 1,3,4,5 |
| Koenigia delicatula(Meissn.) | Dharansi | 3500-4500 | + | - | - | 9 |
| Oxyria digyna(L.)Hiil. | Sarsaupatal | 2500-4200 | + | - | - | 3,4,5,8 |
| Polygonum tubulosum Boiss. | Sarsaupatal | 3500-4600 | + | - | - | 3,8 |
| P.affine D.Don | Sarsaupatal | 3500-4600 | + | - | - | 9,10,11 |
| P.rumicifolium Royle ex Bab. | Pathalkhan | 3500-4000 | + | - | - | 9,11 |
| P.nepalensis Meissn. | Deodi | 2000-3500 | + | - | - | 1,3,4,5 |
| P.polystachyum Wall. ex Meiss. | Deodi | 3000-4500 | + | - | - | 2,9,11 |
| P.vaccinifolium Wall. ex Meissn. | Dibrughetta | 3000-4000 | - | + | - | 2,9,11 |
| P.recumbens Royle ex Bab. | Lata | 2000-2800 | + | - | - | 2,12 |
| P.viviparum L. | Dharansi | 3500-4500 | + | - | - | 3,4,5 |
| P.amplexicaule D.Don | Chinabari | 2500-4500 | + | - | - | 1,3,9,11 |
| P.capitatum Buch.-Ham. ex D.Don | Kalikona | 2300-2500 | + | - | - | 6,7 |
| Rheum australe | Dibrughetta | 2700-3500 | + | - | - | 1,2 |
| R.speciforme Royle | Pathalkhan | 3500-4200 | + | - | - | 3,9 |
| R.webbianum Royle | Dibrughetta | 3500-4000 | + | - | - | 3,9 |
| Rumex acetosa L. | Malla Dibrughetta | 3500-4000 | + | - | - | 9 |
| R.nepalensis Spreng. | Dibrughetta | 2000-4200 | + | - | - | 3,9 |
| R.hastatus D. Don | Reni,Murana | 2000-2200 | + | - | - | 2,6,7 |
| **Aristolochiaceae** | | | | | | |
| Aristolochia dilatata Br. | Chhinabari | 2500-3000 | - | + | - | 1 |
| Thymelaeaceae | | | | | | |
| Daphne papyracea Wall. ex Steud. | Kalikona | 2200-2600 | - | + | - | 1 |
| Stellera chamaejasme Amoen. | Sarsaupatal | 3000-4000 | + | - | - | 9,11 |
| Wikstroemia canescens Meissn. | Kalikona | 2200-2500 | - | + | - | 1 |
| **Elaeagnaceae** | | | | | | |
| Elaeagnus parvifolia Wall. ex Royle | Chhinabari | 2200-3000 | - | + | - | 1 |
| Hippophae rhamnoides Serv. | en route to Deodi. | 3500 | - | + | - | 4 |

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|---|---|---|---|---|---|---|
| H.salicifolia D.Don | Dudhganga | 2500-3000 | - | - | + | 4 |
| H.tibetana Schlecht. | North Sanctuary,<br>Sarsaupatal | 4000-4500 | - | + | - | 4 |
| Loranthaceae | | | | | | |
| Korthalsella opuntia(Thunb.) Merr. | Lata | 2300-2500 | - | + | - | 15 |
| Dendrophthoe falcata(L.f.) Etting | Lata | 2300-2500 | - | + | - | 15 |
| Santalaceae | | | | | | |
| Thesium himalense Royle ex | Bhujgara | 3000-3500 | + | - | - | 15 |
| Osyris quadripartita Salz. | Lata to | | | | | |
| ex Decne. | Beltakharak | 2400-2700 | - | + | - | 2 |
| Euphorbiaceae | | | | | | |
| Euphorbia pilosa L. | Dibrughetta | 2400-3500 | + | - | - | 1,3,9 |
| E.stracheyi Boiss. | Sarsaupatal, | 3500-4500 | + | - | - | 9 |
| E.prolifera Buch.-Ham. | en route to | 2300-2400 | + | - | - | 2 |
| exD.Don | Murana | 2200-2500 | - | + | - | 2 |
| Excoecaria acerifolia Didrichs | Chhinabari<br>North Sanctuary | | | | | |
| **Buxaceae** | | | | | | |
| Sarcococca saligna(Don) Muell.-Arg. | Chhinabari | 2300-2600 | - | + | - | 1 |
| **Ulmaceae** | | | | | | |
| Celtis australis L. | Kalikona | 2200-2500 | - | - | + | 1 |
| Ulmus wallichiana Planch. | Chhinabari | 2300-2600 | - | - | + | 1 |
| **Cannabaceae** | | | | | | |
| Cannabis sativa L. | Lata | 2000-2600 | + | - | - | 2,12 |
| **Urticaceae** | | | | | | |
| Parietaria micrantha Ledeb. | Chhinabari | 2500-3500 | + | - | - | 2,7 |
| Urtica dioica L. | Latakharak | 2500-3600 | + | - | - | 2 |
| U.parviflora Roxb. | Lata | 2000-3500 | + | - | - | 1,2,3,5 |
| Gerardenia heterophylla | Lata to | | | | | |
| Decne | Beltakharak | 2200-2600 | + | - | - | 1,3 |
| Debregeasia longifolia (Burm. f.) Wedd. | Lata | 2200-2600 | - | - | + | 2 |
| Moraceae | | | | | | |
| Ficus palmata Forssk. | Reni | 2000-2200 | - | - | + | 2,6,7 |
| F. hederaceae Roxb. | Reni | 2200 | - | + | - | 6,7 |
| Morus serrata Roxb. | Reni | 2000-2200 | - | - | + | 1,2 |
| **Juglandaceae** | | | | | | |
| Juglans regia L. | Chhinabari,<br>Kalicona | 2200-3000 | - | - | + | 1 |
| **Betulaceae** | | | | | | |
| Betula alnoides Buch.-<br>Ham.ex D.Don | Kalikona,<br>Chhinabari | 2300-2600 | - | - | + | 1 |
| B.utilis D.Don | Deodi | 3500-4000 | - | - | + | 1 |
| Corylus jacquemontii Decne | Murana,<br>Chhinabari | 2300-2700 | - | - | + | 1 |
| **Fagaçeae** | | | | | | |
| Quercus floribunda Rehder | Murana | 2200-2500 | - | - | + | 1 |
| **Salicaceae** | | | | | | |
| Salix denticulata Ander. | Dudhganga | 2300-3600 | - | + | - | 1,2,5 |
| S.hylematica Schneid. | Bhujgara | 3500-4500 | - | + | - | 9,11 |
| S.karelinii Turcz. | Sarsaupatal | 3500-4500 | - | - | + | 9,11 |
| S.lindleyana Wall.ex Ander. | Sarsaupatal | 3600-4500 | - | + | - | 9,11 |
| S.disperma Roxb.exD.Don | Dibrughetta | 2500-3600 | - | - | + | 1,4 |
| S.calyculata HK.f.Ander. | Bagnidhar | 3500-4500 | - | + | - | 9,11 |
| Populus ciliata Wall.ex Royle | Dudhganga | 2000-3000 | - | - | + | 1,4 |
| **Orchidaceae** | | | | | | |
| Aorchis roborovskii(Maxim)Seed. | Bhujgara | 3500-4200 | + | - | - | 9,11 |
| Calanthe tricarinata Lindl. | Murana | 2300-2600 | + | - | - | 1,3,5 |

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|---|---|---|---|---|---|---|
| Cephalanthera longifolia(L.) Frisich | Chhinabari | 2400-2800 | + | - | - | 1 |
| Cypripedium elegans Reichb. | Dharansi | 3800 | + | - | - | 9,11 |
| C.himalaicum Rolf. | Dibrughetta | 3400-4000 | + | - | - | 9,11 |
| Dactylorhiza hatagirea(D.Don) 500 | Dibrughetta | 3000-4000 | + | - | - | 9 |
| Epipogium aphyllum(Schm.)Summa | Himtoli | 3000 | + | - | - | 1,3 |
| Goodyera repens(L.)R.Br. | Deodi | 2500-4000 | + | - | - | 1 |
| G.biflora | Chhinabari | 2490-3000 | + | - | - | 1,3 |
| G.fusca(Lindl.)HK.f. | Sarsaupatal | 3500-4500 | + | - | - | 9,11 |
| Gymnadenia orchidis L. | Dibrughetta | 3400-3600 | + | - | - | 9 |
| Herminium monorchis(L.)R.Br. | Deodi | 3000-3800 | + | - | - | 3,6,9 |
| Listera tenuis Lindl. | Ramni,Deodi | 3500-4000 | + | - | - | 1,3 |
| Malaxis muscifera(Lindl.)Ktz. | Dharansi | 3800 | + | - | - | 9 |
| Neottia listeroides Lindl. | Latakharak | 2600-3300 | + | - | - | 1,3 |
| Neottianthe secundiflora(HK.f.) Schltr. | Dharansi | 3600 | + | - | - | 6,9 |
| Oreorchis micrantha Lindl. | Deodi | 2400-3300 | + | - | - | 1 |
| Peristylus eligabethae(Duthie) | Latakharak | 3000-3800 | + | - | - | 1 |
| Epipactis helleborine(L.)Crantz | Chhinabari | 2490-3000 | + | - | - | 1 |
| Habenaria edgeworthii HK.f.exCo. | Latakharak | 2500-3000 | + | - | - | 1 |
| Ponerorchis chusua D.Don | Dharansi | 3800 | + | - | - | 9,11 |
| **Haemodoraceae** | | | | | | |
| Aletris pauciflora(Klotz.) Hand.-Mazz. | Trishul nullah | 3600-4500 | + | - | - | 2,9 |
| Ophiopogon intermedius D.Don | Chhinabari | 2400-3000 | + | - | - | 1,3 |
| **Iridaceae** | | | | | | |
| Iris kumaonensis D. Don ex Royle | Dibrughetta | 3000-4200 | + | - | - | 9,11 |
| **Smilacaceae** | | | | | | |
| Smilax vaginata Decne | Dibrughetta | 2500-3500 | - | + | - | 1,11 |
| **Dioscoreaceae** | | | | | | |
| Dioscorea deltoidea Wall.ex Royle | Beltakharak | 2400-2800 | + | - | - | 1 |
| **Lillaceae** | | | | | | |
| Allium humile Kunth | Dibrughetta | 3300-4000 | + | - | - | 9 |
| A.stracheyi Baker | Sarsaupatal | 3000-4500 | + | - | - | 9 |
| A.wallichii Kunth. | Dibrughetta | 3300-3600 | + | - | - | 9 |
| Asparagus filicinus Buch.- Ham.exD.Don | Latakharak | 2500-3000 | + | - | - | 1 |
| Clintonia udensis Traut.&Mey | Latakharak | 3000-3500 | + | - | - | 1 |
| Lilium wallichianum Schult. & Schult. | Pangrani | 2800-3500 | + | - | - | 2,7,9 |
| Lloydia longiscapa HK. | Sarsaupatal | 4000-4500 | + | - | - | 9,11 |
| L.serotina (L.)Reichb. | Ramni | 3500-4000 | + | - | - | 7,9,11 |
| Nomocharis nana(Klotz.)Wilson | Trishulnullah | 3600-4000 | + | - | - | 9 |
| N.oxypetala(Royle)Wilson | Dibrughetta | 3000-4000 | + | - | - | 9 |
| Polygonatum cirrhifolium (Wall.)Royle | Deodi | 2500-4000 | + | - | - | 1,9 |
| P.graminifolium HK. | Dibrughetta to Deodi | 3500-3800 | + | - | - | 9 |
| P.verticillatum (L.)All. | Dibrughetta | 2300-4000 | + | - | - | 1,3,9 |
| Smilacina purpurea Wall. | Dibrughetta | 2700-4000 | + | - | - | 1,3 |
| Trillidium govanianum (D.Don)Kunth | Chhinabari, | 3000-4000 | + | - | - | 1,3 |
| Paris polyphylla Sm. | Kalicona | 2200-4000 | + | - | - | 1,3 |
| Fritillaria roylei D.Don | Malla Dibrughetta | 3500-4000 | + | - | - | 9 |
| **Juncaceae** | | | | | | |
| Juncus concinnus D.Don | Deodi | 3000-4000 | + | - | - | 3,9 |
| J.himalensis Klotz. | Pathalkhan | 3500-4000 | + | - | - | 5,8 |
| J.membraneus Royle ex D.Don | Sarsaupatal | 4000-4500 | + | - | - | 9 |
| **Araceae** | | | | | | |
| Arisaema Jacquemontii Bl. | Beltakharak | 2000-3000 | + | - | - | 1,3,7 |
| A.flavum(Forsk.)Schott. | Latakharak | 3500-4000 | + | - | - | 1,7 |
| A.intermedium Bl. | Latakharak | 2500-4000 | + | - | - | 1,7 |
| A.tortuosum(Wall.)Schott. | Lata to | 2400-2600 | + | - | - | 1,7 |

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|---|---|---|---|---|---|---|
| | Beltakharak | | | | | |
| **Cyperaceae** | | | | | | |
| Carex cardiolepis Nees | Sarsaupatal | 4000-4500 | + | - | - | 9 |
| C.duthiei Cl. | Ramni, Pathalkhan | 3500-4500 | + | - | - | 9 |
| C .inanis Kunth | Deodi | 2500-3500 | + | - | - | 1,3 |
| C.lehmani Drejer | Bhujgara | 3500-4000 | + | - | - | 1 |
| C.nivalis Boott. | Bhujgara | 3200-4000 | + | - | - | 9,11 |
| C.nubigena D.Don | Dibrughetta | 3400-4000 | + | - | - | 9,11 |
| C.obscura Nees | Himtoli | 2500-3000 | + | - | - | 1,3 |
| C.setosa Boott. | Barapani | 3300-3800 | + | - | - | 1,5 |
| Cyperus cuspidatus Kunth | en route Deodi | 3000-4000 | + | - | - | 1,9 |
| Fimbristylis dichotoma(L.)Vahl | Reni to Lata | 2000-2600 | + | - | - | 1,7 |
| Kobresia capilifolia(Decne)Cl. | Ramni to Bhujgara | 3500-4000 | + | - | - | 9,11 |
| K.deasyi Cl. | Dharansi | 4000-4500 | + | - | - | 9 |
| K.laxa Nees | Dibrughetta | 3300-4000 | + | - | - | 9,11 |
| K.nepalensis(Nees)Kukenth | Sarsaupatal | 4000-4500 | + | - | - | 9 |
| **Poaceae** | | | | | | |
| Agrostis canina L. | Dharansi | 3300-4200 | + | - | - | 9,11 |
| A.pilosila Trin. var. royleana(Trin.)Bor | Ramni, Bhujgara | 3500-40000 | + | - | - | 9,11 |
| Andropogon munroi Cl. | Latakharak | 2800-3300 | + | - | - | 2 |
| Bromus japonicus Thunb. | Dibrughetta | 3500-4200 | + | - | - | 9,11 |
| B.ramosus Huds. | Deodi to Ramni | 3300-3600 | + | - | - | 9,11 |
| Calamogrostis emodensis Griseb. | Dibrughetta to Deodi | 3300-4000 | + | - | - | 3,9,11 |
| Dactylis glomerata L.ssp. himalayansis Domin | Latakharak | 3500-4000 | + | - | - | 9,11 |
| Danthonia cachemyriana Jaub. | Dibrughetta & Spach. | 3000-4000 | + | - | - | 2,9,11 |
| D.jacquemontii Bor | Dharansi | 3500-4000 | + | - | - | 9 |
| Deyeuxia scabrescens(Griseb.) Munro ex Duthie | Dharansi | 3500-4200 | + | - | - | 9,11 |
| Festuca kashmiriana Stapf. | Dharansi | 3500-4500 | + | - | - | 9,11 |
| F.polycolea Stapf. | Dibrughetta | 3500-4000 | + | - | - | 9 |
| Poa alpina L. | Dharansi | 3000-4000 | + | - | - | 1,9,11 |
| P.araratica TRauty | Ramni | 3500-4500 | + | - | - | 1,11 |
| P.pagophyla Bor | Bhujgara | 3500-4200 | + | - | - | 9 |
| Stipa roylei (Nees)Mez. | Dibrughetta | 3500-4500 | + | - | - | 9 |
| Trisetum clarkei(HK.f.)Stewart | Ramni to Bhujgara | 3500-4000 | + | - | - | 9,11 |
| Chrysopogon gryllus(L.)Trin. | Kalikona | 2300-2600 | + | - | - | 2 |
| Apluda mutica L. | Lata | 2000-2500 | + | - | - | 2 |
| Nayraudia arundinacea(L.)Henr. | Reni | 2000-2300 | + | - | - | 2 |
| Cymbopogon distans(Nees ex.Steud.)Wats | Reni | 2000-2200 | + | - | - | 2 |
| Erianthus rufipilus(Steud.) Griseb. | Reni | 2000-2400 | + | - | - | 2 |
| Themeda anathera(Nees exSteud.) Hack. | Reni | 2000-2400 | + | - | - | 2 |
| Cynodon dactylon(L.)Pers. | Lata | 2000-2500 | + | - | - | 2,12 |
| Arundinaria falcata Nees | Chhinabari | 2300-2800 | - | + | - | 1 |
| Chimonobambusa jaunsarensis (Gamble)Bahadur&Naithani | Malla Chhinabari | 2400-2800 | - | + | - | 1 |
| Thamnocalamus spathiflora(Trin.) | Dibrughetta | 2700-3300 | - | + | - | 1 |
| T.falconeri HK.f.ex Munro | Chhinabari | 2500-3300 | - | + | - | 1 |
| **Gymnosperms** | | | | | | |
| **Ephedraceae** | | | | | | |
| Ephedra gerardiana Wall.ex Stapf. | Pathalkhan | 3500-4500 | - | + | - | 6,9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Cupressaceae** | | | | | | |
| Juniperus indica | Dibrughetta | 3200-4200 | - | + | - | 1,9,11 |
| J.communis L. | Parkuriadhar | 3500-4500 | - | + | - | 9,11 |
| J.recurva Buch.-Ham.ex D.Don | Bagnidhar | 3600-4000 | - | + | - | 9,11 |
| Cupressus torulosa D.Don | Lata | 2000-2600 | - | - | + | 1 |
| **Taxaceae** | | | | | | |
| Taxus baccata L. | Malla Chhinabari | 2400-3500 | - | - | + | 1 |
| **Pinaceae** | | | | | | |
| Abies spactabilis(D.Don)Mirle. | Dibrughetta | 3000-4000 | - | - | + | 1 |
| A.pindrow Royle | Chhinabari | 2300-3000 | - | - | + | 1 |
| Picea smithiana(Wall.)Boiss. | Chhinabari | 2200-2600 | - | - | + | 1 |
| Pinus wallichiana Jacks. | Dibrughetta | 2200-4000 | - | - | + | 1 |
| Cedrus deodara(Royle ex D-Don) G.Don | Tolma,Lata | 2200-2600 | - | - | + | 1 |

**Abbreviation used;** H;Herb,Shb;Shrub,T;Tree,1;Forests,2;Exposed,3;Shady moist,4;Riverine 5;Water courses,6;Rocks/Boulders, 7;Rock crevices/under boulders, 8;Marsh/wet, 9;Alpine pastures/alpine slopes,10;Moraines,11;Shrubbrries 12;Way sides/road sides,13;Epiphytes,14;Saprophytes,15;Parasites.

# Appendix - 2

## Pterodophytes

| Botanical name/family | Locality (m) | Altitudinal range | Habitat |
|---|---|---|---|
| Botrychiaceae | | | |
| Botrychium lunaria (L.) Sw. | Mallachhinabari, enroute to Deodi | 2700-3700 | 1,9 |
| B.ternatum (Thunb.) Sw. | Chhinabari | 2500 | 1 |
| B.otrypus lanuginosus (Wall.ex HK & Grev.) Holub. | Kalikona | 2370 | 1 |
| Ophioglossaceae | | | |
| Ophioglossum reticulatum L. | Mallachhinabari, Kalikona, | 2370-2600 | 1 |
| **Osmundaceae** | | | |
| Osmunda claytoniana L. | Lala Kharak | 3000-3800 | 9 |
| **Grammitaceae** | | | |
| Ctopnopteris subfalcata (Bl.) Presl | Chhinabari | 2500 | 6 |
| **Loxogrammaceae** | | | |
| Loxogramme involucrata (D.Don) Presl | Rishi Ganga Gordge | 2300-2600 | 6, 13 |
| **Polypodiaceae** | | | |
| Drynaria mollis Bedd. | Kalikona Dib. | 2350-4000 | 13 |
| Lepisorus jakonensis (Blanf.) Ching | Between Chinabari and Deodir Ganga | 2400-2800 | 6, 13 |
| L. excavatus (Bory) Ching | Chinabari | 2300-2600 | 13 |
| L. morrisonensis | Chhinabari | 2200-2600 | 6, 13 |
| Phymatopteris ebenipes (HK.) Pichi Sermoli | Ramni | 3000-3800 | 13 |
| P.stracheyi (Ching) Pichi Sermoli | Dibrughetta | 3400-4000 | 6, 13 |
| Polypodioides amoena (Wall. ex Mett.) Ching | Chhinabari | 2200-2600 | 6, 13 |
| Pyrrosia sticta (Kunz.) Holtt. | Between Reni to Lata | 2200 | 6, 13 |
| **Sinopteridaceae** | | | |
| Cheilathes albomarginata Cl. | Chhinabari, Murana | 2200-2600 | 6, 13 |
| C. dalhousiae HK. | Dibrughetta | 2600-4000 | 6, 13 |
| Notholaena marantae (L.) Desv. | Divrughetta Chhinabari | 2500-4000 | 7, 11 |
| **Cryptogrammaceae** | | | |
| Cryptogramma brunoniana Wall. ex HK.f.& Grev. | enroute to Chhinagari Dibrughetta, Deoti | 2400-4000 | 7 |
| C. stellari (Gmel.) Prantl. | Malla Deodi Pathalkan to Sarsaupatat | 3500-4200 | 7 |
| Onychium contiguum Hope | Murana, Mallachhinabari | 2200-2600 | 2 |
| **Pteridiaceae** | | | |
| Pteris cretica L. | Kalikona | 2000-2800 | 1 |
| P. dactytina HK. | Between Kalikona to Chhinabari | 2350-2800 | 7 |
| P. excelsa Gaud. | -do- | 2300-2800 | 7 |
| P. quadriaurita Retz. | Rishi Ganga gordge | 2400-2800 | 1 |
| P. stenophylla Wall. ex HK. et Grev. | -do- | 2300-2700 | 7 |

| | | | |
|---|---|---|---|
| **Adiantaceae** | | | |
| Adiantum capillus-veneris L. | Reni | 2100 | 5 |
| A. venustum D.Don | Dudhganga | 2200-3600 | 1 |
| A. edgeworthii HK. | Kalikona<br>Dibrughetta | 2350-4000 | 6, 7 |
| **Hemionitidaceae** | | | |
| C. intermedia Hieron Va. glabra Ching | Lata to Beltakharak | 2400-2700 | 1 |
| Gymnopteris vestita Wall. ex Underw. | en route to Chhinabari 2 | 2400 | 7 |
| **Hypolepidaceae** | | | |
| Hypolepis punctata (Thunb.) Mett. | Reni, Lata | 2000-2300 | 2 |
| **Dennstaedtiaceae** | | | |
| Emodiopteris appendiculata (Wall. ex HK.) Ching & Wu. | Chhinabari | 2500-2700 | 2 |
| **Pteridiaceae** | | | |
| Pteridium aquilinum (L.) Kuhn. var. weightianum (Ag.) Tryon | en route to Chhinabari | 2400 | 1, 2 |
| **Thelypteridaceae** | | | |
| Psoudophegopteris leveingi (Cl.) Ching | Dibrughetta<br>Dudhganga | 2500-3500 | 7 |
| **Aspleniaceae** | | | |
| Asplenium capillipes Makino | Chhinabari<br>Deodi | 2500-3500 | 7 |
| A. dalhousiae HK. | Chhinabari | 2200-3000 | 2, 3 |
| A. ensiforme Wall.ex HK. & Grev. | Rishi ganga gordge | 2300-2800 | 6, 13 |
| A. khullarii Viane | Dibrughetta<br>Dudh ganga | 3000-4000 | 7 |
| A. trichomanes L. | Malla Chhinabari | 2600-3500 | 13 |
| A. varians Wall.ex. HK. et. Grev. | Mallachhinabari | 2200-3000 | 1, 3, 6 |
| A. viride Hudson | Deodi | 3300-4000 | 6, 7 |
| A. septentrionale (L.) Hoffm. | Dharansi to Dibrughetta | 3500-4000 | 7 |
| **Woodsiaceae** | | | |
| Woodsia andersonii (Bedd.) Christ. | Parkuridher | 3700 | 6, 7, 11 |
| W. elongata HK. | Between Chhinabari & Dudh Ganga | 2400-3300 | 6, 7, 11 |
| W. lamosa HK. | Malla Deodi | 3300-4000 | 7, 11 |
| Woodsia cycloloba Hand. - Mazz. | Ramrii<br>Bhujgara | 3500-4000 | 7, 11 |
| **Athyriaceae** | | | |
| Athyrium anisopterum Christ | Murana,<br>Kalikona | 2200-2500 | 1, 2 |
| A. attenuaum (Cl.)Tag attenuatum | Dibrughetta | 2700-3500 | 1, 9 |
| A. foliolosum Wall. ex Sim. | Latakharak | 2500-3200 | 7 |
| A. rubricaule (Edgew.) Bir | Dibrughetta<br>Dudh Ganga | 3000-4000 | 11 |
| A. rupicola (Hope) Chr. | Belta Kharak | 2500-300 | 3, 7 |
| A. schimperi Moug. ex Fee. | Latakharak | 2500-3200 | 1, 3 |
| A. tenuiforme (Wall. ex. Moore) Sim | Latakharak | 2400-2800 | 1 |
| A. wallichianum Ching | Malla Dibrughetta | 3500-400 | 9, 11 |
| Cystopteris dickieana Sim. | Bagni Dhar | 3700 | 7 |
| C. fragilis (L.) Bernh. | Dibrughetta, Deodi | 3300-4000 | 7 |

| | | | |
|---|---|---|---|
| C. montana (Lam.) Bernh. ex. Desv. | Bagnidhar | 3500-4000 | 7 |
| Diplazium esculentum (Retz.) Sw. | Lata | 2000-2400 | 11 |
| Gymnocarpium dryopteris (L.) Newn. | Dudh Ganga | 3000-3500 | 5 |
| **Aspidiaceae** | | | |
| Cyrtomium caryotideum (Wall. ex HK. & Grev.) Presl. | Kalikona | 2200-2600 | 1, 3 |
| **Dryopteridaceae** | | | |
| Dryopteris barbigera (HK.) Ktze. | Dibrughetta | 3500-4000 | 9 |
| D.Chrysocoma (Christ) C. Chr. | Belta Kharak | 2300-3000 | 1 |
| D. juxtaposita Christ | Beltakharak | 2300-2600 | 1 |
| D. panda (Cl.) Christ | Dibrughetta, Deodi | 3300-3600 | 7 |
| D. wallichiana (Spr.) Hyl. | Deodi | 2500-3500 | 1 |
| D. brunoniana (Wall.) Kuntze. | Dharansi | 3500-4000 | 9 |
| Polystichum bakerianum (Aitk. ex. cl.)Diels | Bagnidhar, Rammi | 3000-4000 | 9, 11 |
| P. lachenense (HK.) Bedd. | Pathalkhan | 3000-4000 | 7 |
| P. mehrae Fraser Jenkins & Khullar | Ganga gordge | 2200-2600 | 7 |
| P. prescottianum (Wall. ex. Mett.) Moore | Dibrughetta | 3000-3800 | 9, 11 |
| P. squarrosum (D.Don) Fee | Latakharak | 2200-3000 | 1 |
| P. stimulans (Kuntz. ex. Mett.) Bedd. | Chinwari | 2500-3000 | 1 |
| P. thomsonii (HK.) Bedd. | Rishi Ganga gordge | 2300-2700 | 1 |
| P. wilsonii Christ. | Pathalkhan | 3500-4500 | 9, 11 |
| **Davalliaceae** | | | |
| Araiostegia beddomei (Hope) Ching | Ramni | 3300-4000 | 1, 13 |
| A. pseudocystopteris (Kuntz.) Copel. | Rishi Ganga gordge. | 2300-2800 | 1, 13 |
| Leucostegia immersa Presl. | Reni, Lata | 2000-2200 | 6, 7 |

Key : 1 = Forests; 2 = Exposed; 3 = Shady moist;
4 = Riverine; 5 = Water courses; 6 = Rocks/boulders;
7 = Rock crevices/under boulders; 8 = Marsh/wetlands;
9 = Alpine pastures/slopes; 10 = Moraines; 11 = Wasysides/roadsides;
13 = Epiphytes.

# EXPEDITION TO NANDA DEVI : FLORISTIC ANALYSIS

B. BALODI

BOTANICAL SURVEY OF INDIA, NORTHERN CIRCLE,

DEHRADUN

## INTRODUCTION

The varied physiographic and climatic conditions met indifferent parts of India, supports highly luxuriant and diverse flora than that of any other country, of comparable size, in the eastern hemisphere. About 45,000 species, belonging to various plant groups are estimated to occur in India. Of these *ca* 15,000 species are of flowering plants (Phanerogams) alone which includes *ca* 7000 taxa - so far not knwn to occur beyond the present political boundary of our country.

The rich floristic resources of our country notwithstanding,out vegetational wealth has considerably depleted, both qualitatively as well as quantitatively, in recent times owing to various reasons. In this process many species of plants have suffered destruction and reached the threatened category, some are even considered to have become extinct. The dependence of man on plant resources, for his various basic requirements is too well known to be emphasised. Ironically, however, the man himself began to destroy the same resources from the advent of civilisation through various anthropogenic practices particularly the expansion of biotic activities in primeval forest areas and the over-exploitation of natural resources. This coupled with the forces of population growth, today threaten to destroy the delicate equilibrium that exists between the man and the biosphere.

Realising the implications of such disastrous circumstances, directly influencing the very existance of a man that various conservational programmes have been launched world over to both *in situ* as well as *ex situ* conservation of plant resources.

The programme of Biosphere Reserve is one such measure, which was initiated under the 'Man & Biosphere (MAB) Programme' by UNESCO in 1973-74 and intends to provide long term *in situ* conservation to all the biotic communities viz., plants, animals and micro-organisms to facilitate self perpetuation and undistrubed evolution of the entire living resources. Biosphere Reserve supports and complements the protected areas like National Parks, Wildlife Sanctuary and Reserves, etc. While sanctuaries are mainly species-oriented and National Parks habitat-oriented, the Biosphere Reserve represents the entire biodiversity of a biogeographic area including the species diversity, the genetic diversity and the system diversity.

Nanda Devi Biosphere Reserve, one of the 7 biosphere Reserve areas declared so far in India came into existence on January 1st, 1988. The region was almost *terra incognita* till 1934 when Tilman and Shipton penetrated the hidden valley and opened the route to Nanda Devi through Rishi Ganga. This pristine area was thus exposed to the rigors of biotic interferences, caused mostly by various mountaineering expeditions, unauthorised herb collectors & poachers year after year, leading to the damage and destruction of both flora and fauna.

A recent study conducted in the core zone of the bioshpere (formerly Nanda Devi National Park) revealed 312 plant species distributed over 199 genera and 81 families (Hajra, 1983), which included many rare plants such as *Aconitum* Sp. *Podophyllum hexandrum, Cypripedium elegans, Picrorhiza kurrooa* etc. Hajra (l.c.) also discussed different biotic factors straining the natural vegetation in the area. Subsequently, documentation and conservation of floristic resources of our country, undertook detailed study of the flora of Nanda Devi Biosphere Reserve including both core as well as the buffer zone of this reserve. Consequently *ca* 800 species of plants have been recorded from this region as a result of intensive survey conducted in the area during past 4 years by P.K. Hajra and B. Balodi.

## OBJECTIVES

a. Abundance of flora and fauna.

b. Extent of regeneration in the degraded vegitation along the Nanda Devi base camp trek.

c. The status of rare/endangered species of both flora as well as fauna, and finally.

d. To study the effect of garbage left behind by earlier expenditions and to clear the same. Besides, it also envisages to evolve different parameters to serve the management requirements of the Biosphere Reserve.

Keeping in view the above objectives, the author was deputed to participate in the expedition to complement its floristic aspect.

### General vegetation :

During the expedition the route to the core zone through Rishiganga gorge was followed. The vegetational composition of the area may be summerised as follows :

### 1. Broad-leaved mixed forest :

From village Reni (1900 m) the *Acer caesium Jaglans regia, Toona serrata, Prunus cornuta, Corylus jacquemontii, Aesculus indica, Lyonia ovalifolia, Rhododendron arboreum, Celtis macrophylla, Abies spectabilis, Quercus floribunda, Viburnum continifolium, Berberis aristata, Cotoneaster bacillaris, Colquhonia coccinea, Betula alnoides, Rubus lasiocarpus, R. foliolosus are common.* The herbaceous vegetation is represented by *Viola serpens, V. biflora, Fragaria nubicola, Anemone vitifolia, Paeonia emodi, Delphinium denudatum, Polygonatum verticillatum, P. cirrhifolium* etc. The ground orchids *Calanthe plantaginea* and *C. tricarinata* are also common through out the area. Around 2500-2700 m in this region *Acer acuminatum, Picea smithiana, Abies spactabilis, Corylus jaquemontii, Celtis* *macrophylla, Populus* sp. *Sorbaria tomentosa, Eurya acuminata, Rhododendron arboreum, Rubus lasiocarpus, Viburnum cotinifolium* and *Salix denticulata* are common.

The herbaceous plants of this region are *Bergenia ciliata, Ainsliaea aptera, Jurinea dolomiaea, Viola biflora, V. serpens, Calanthe tricarinata, Actaea spicata* and a saprophytic herb *Orobanche himalaica* are common. Throughout this area *Thamnocalamus folconeri, Thamnocalamus spathiflora and Chimonobambus jaunsarensis* are abundant.

From Kali Kona (2575 m) to Chinwari (2490 m) the forest vegetation is almost same. *Deutzia Rhamnus sp., virgatus, Rubus lasiocarpus, Corylus jacquemontii, Acer caesium, Acer acuminatum, A. cappadocicum, Picea smithiana, Euonymus fimbriatus, Prunus cornuta, Salix elegans, S. denticulata, Betula alnoides, Berberis petiolaris, Rhamnus triqueter, Elaeagnus parvifolia* are common throughout.

The herbaceous vegetation is represented by *Paeonia emodi, Anaphalis triplinervis, Micromeria biflora, Viola serpens, Polygonum amplexicaule, Polygonatum verticillatum, P. cirrhifolium, Jurinea dolomiaea.*

Chinwari (2490 m) to Dhudhganga (2940).

The *Populus, Salix denticulata, S. elegans, Syringa emodi, Berberis aristata, B. pseudumbellata, B. umbellata, Rhododendron arboreum.*Here the coniferous trees are represented by *Pinus wallichiana, Picea smithiana, Abies pindrow,* and Taxus baccata, Chimonobambusa jaunsarensis, Thamnocalcamus spathiflorus, T. falconeri, Cotoneaster bacillaris are also dominant in the area.

### Abies-Betula forest

Just afer Dudhganga (2940 m) towards Debrugheta (3420 m) the *Abies spectabilis* and *Betula utilis* are forming the top canopy, a few trees of *Taxus baccata* and *Pinus wallichii* are also present in the area. Shruby vegetation is represented by the *Thamnocalamus spathiflorus, Ribes glaciale, R. alpestre, R. grossularia, Lonicera obovata, L. hypoleuca, Rosa webbiana, R. sericea, Berberis pseudumbellata, Salix denticulata, S-fruticulosa, S. karelini.* The large shrub of *Rhododendron canpanulatum* and small shruby *Rhododendron anthopogon* and *R. lepidotum* are also common in the area. *Cotoneaster microphylla* and *Lonicera spinosa* are common on open hill top. The common herbs in this forest type are *Ligularia arnicoides, L. amplexicaulis, Cremanthodium arnicoides, Primula denticulata, P. macrophylla, Genetiana capitata, Genetiana argentea, Potentilla argyrophylla, Fragaria nubicola, Thymus serpyllum, Polygonum affine, P. nepalensis, P. polystachyum, P. vaccinifolium, Rumex nepalensis, Phlomis bracteosa, Origanum vulgare, Androsace sarmentosa, Nepeta discolor, Ajuga parviflora, Rheum spiciforme, R. webbianum, Pedicularis pectinata, Bergenia stacheyi,* etc. Around Dibrugheta the medum sized shrubs *Piptanthus nepalensis* with *Rhododenderon anthropogon, R. lepidotum, Cotoneaster microphyllus* and *Berberis edgeworthiana* are dominant.

This Abies-Betula forest prevails upto Ramni (3500 m). Around Ramni prostrate shrubs of *Caragana nubigena* and small herb *Lloydia serotina* (probably a new variety) are among the interesting plants on way from Deodi to Ramni. The author could also see a few plants of *Picrohiza kurrooa* growing on open slopes in sandy soils. In this type of forest vegetation the *Abeis/Betula* forest type *Sorbus microphylla* and *Viburnum erubescens* are the important components of vegetation.

Betula-Rhododendron forest :

As we go up towards the tree line the *Betula utilis* and *Rhododendron campanulatum* starts forming the top canopy and *Abies spectabilis* starts losing its density and ultimately it disappears. In this type of forest shrubs are represented by *Rosa webbiana, R. sericea, R. anserinaefolia, Ribes himalense, R. glaciale,* small trees, *Sorbus aucuparia, S. microphylla,* large shrubs of *Viburnum erubescens,* small prostrate shrubs of *Astragalus rhizanthus, Caragana nubigena, Berberis edgeworthiana, Contoneater microphyllus* and *C. integrifolius* are common. The herbaceous vegetationis represented by *Androsace globifera, Saxifraga jacquemontiana, S. brachypoda, S. brunonis, S. asarifolia, Arenaria festucoides, A neelgerrensis, Primula minutissima, Silence gonosperma, Primula denticulata, P. macrophylla, Swertia cuneata, S. ciliata, potentilla argyrophylla, P. cuneata,* etc.

Alpine meadows:

High level grasslands generally found above the tree line. These alpine meadows are locally known as 'BUGYALS'. During the rainy season these areas are found full of herbaceous plants of different shape, sizes and *colours. The common plants are Potentilla argyrophylla, P. atrosanguinea, Selinum elatum, Thermopsis barbata, Lotus corniculata, Taxaxacum officinale, Morina coulteriana, M. longifolia, Androsace sarmentosa, A. globifera, Arnebia benthamii, P. denticulata, P. macryphylla, P. minutissima, Genetiana argentea, G. capitata, G. venusta, G. pedunculata, Swertia ciliata, S. cuneata, Myosotis sylvatica, Pedicularis pectinata, P. hoffmeisteri, P. punctata, Veronica capitata, V. lanosa, Phlomis bracteosa, Thymus serpyllum, Rumex nepalensis, Polygonum affine, P. amplexicaule, Oxyria, digyna, Anaphalis contorta, A. nepalensis, Aster diplotephioides, Dubyaea hispida, Erigeron multiradiatus, Ligularis sibirica, Saussurea obvallata, Senecio alatus, S. chrysanthemoides, Tanacetum tomentosum, Valeriana dioica, Pleurospermum densiflorum, P. angelicoides, Eriocycla thomsonii, Chamaesciadium garhwalicum, Sedum multicaule, Rhodiola sinuata, R. quadrifida, R. hererodonta, Saxifraga granulifera, S. sanginoides, Delphinium vestitum, D. denudatum, Anemone polyanthes, A. obtusiloba, A. rupicola, Aconitum violaceum, Oxygraphis polypetala, Paraquilegia anemonoides, Ranunculum pulchellus, R. hirtellus, Thalictrum reniforme, T. elegans, T. cultratum, Arenaria festucoides, A. musciformis, A. ciliolata, Geranium donianum, G. wallichianum, Thylacospermum caespitosum* and *Meconopsis aculeata.*

Highly medicinal and rare ground orchid *Dactylorhiza hatagirea* is found to grow in good number in Debrugheta bugyal. In 40 x 6 m plot as many as 49 dried species of this precious plant, were found.

Rare plants

*1. Aconitum violaceum Jacq. ex Stapf (Ranunculaceae)*

Found to grow only around Dharansi area and exploited for its medicinal properties.

*2. A. heterophyllum* Wall.

This plant has become rare due to its over exploitation for its medicinal properties.

3. *Circaeaster agrestis* Maxim. *(Circaeasteraceae).*

The genus is monotypic, always grow under boulders and show a restricted range of distribution.

4. *Cypripedium elegans* Reichb.f. *(Orchidaceae).*

These ground orchids are found only between Deodi and Debrugheta originally known to come from Sikkim.

5. *C. himalaicum Rolfe* ex Hemsl. *(Orchidaceae)*

These are also restricted in between Deodi and Dibrugheta.

6. *Podophyllum hexandrum* Royle *(Podophyllaceae).*

This plant has become rare due to its over exploitation for its medicinal properties and less distribution.

7. *Dactylorthiza hatagirea* (D. Don) *Soo (Orchidaceae).*

This ground orchid also over exploited for its medicinal properties.

8. *Meconopsis aculeata* Royle *(Papaveraceae).*

This blue poppy rare due to its restricted distribution and typical habitat condition.

9. *Saussurea obvallata* (DC.) *Sch.-Bip.*

This large beautiful, white flowered plant is su pposed to be very sacred for this it is over exploited from the natural habitat.

10. *Nardostachys grandiflora DC. (Valerianacee).*

This thick rooted medicinal plant has become rare due to its over exloitation.

11. *Picrorhiza kurrooa Benth. (Scrophulariaceae).*

This plant has also become rare due to its over exploitation for its medicinal properties.

12. *Stellera chamaejasme L. (Thymelaeaceae).*

These sweet-scented yellow flowered plants are monotypic with restricted distribution found to grow in Sarson patal and Himtoli area.

Important medicinal plants

1. *Aconitum balfourii Stapf (Ranunculaceae).*

These are 0.3-1.0 m high herbs. Roots tuberous posonous. Flowers blue "BISH"

*Uses:* Tuberous roots are source of Aconite which is used externally for rheumatism and internally to relieve pain and fever.

*Distrib:* Deodi - Ramni 'Rare'.

2. *A. heterophyllum Wall.*

These are 20-70 cm high herbs. Roots tuberous, leaves stem clasping. Flowers dull-green.

"ATIS", "MITHU".

*Uses:* Roots used as astringent and tonic. Also used in diorrhoea and cough.

*Distrib:* Dibrugheta - Deodi, Chinwari - Dudhganga

*3. Arnebia benthamii (Wall.ex D.Don) Johnston (Boraginaceae).*

These are 50-70 cm high, densely hispid deep rooted perennial herbs. Flowers purplish white.

"RATANJOT", "LALZARI"

*Uses:* The thick root system is cut and dipped in mustard oil and used as hair tonic

*Distrib:* Dibrugheta top - Sarsopatal- Mpt cp, pm-

*4. Dactylorhiza hatagirea (D.Don) Soo (Orchidaceae).*

These are the terrestrial orchids with palmate tubers. Flowers pink-purple.

"HATTAZARI"

*Uses:* Tubers are edible and used as tonic, also used as healing agent.

*5. Dioscorea deltoidea Wall.ex Kunth (Dioscoreaceae)*

Glabrous clibbers, turning to left. Leaves simple. Male spikes solitary.

"GENTHI" "KILDRI"

*Uses:* Tubers used in piles, dysentary, ulcer and insexu al diseases.

*Distrib:* Kalikana forest. Rare.

*6. Nardostachys grandiflora DC. (Valerianaceae)*

These are 20-35 cm high herbs. Rootstocks thick. Leaves spathulate. Flowers pinkish.

"JATAMANSI, "MANSI".

*Uses:* The roots are used for treatment of epilepsy and hysteria. Also used in palpitation of heart.

*Distrib:* Ramni - Bhujgara.

7. *Picrohiza kurooa* ex Nemtj *(Scrophulariaceae).*

These are 15-40 cm high herbs. Rootstocks thick covered throughtout with leaf bases. Leaves spathulate. Flowers bluish-white.

"KATKI", "KURU".

*Uses:* The roots are used in fever dyspepsia, in scorpion sting and pargative preparation.

*Distrib:* Deodi to Ramni.

*8. Rheum webbianum Royle, R. tibeticum Maxim ex Hook.f., R. Moorcroftiana Rolyle (Polygonaceae).*

There are deep rooted parennial herbs with broad leaves. Flowers pale-yellow.

"DOLU".

*Uses:* Ropots are purgative, stringent and tonic, also used in muscular pain and internal injury.

*Distrib:* Through out the area in Abies-Betula forest land in Alpine meadows.

*9. Podophyllum hexandrum Rolyle (Podophyllaceae).*

These are succulent erect herbs with 2-leaves. Flowers solitary purplish-white.

"PAPRA".

*Uses:* Rhizomes are used as hepatic stimulant, also as purgative.

*Distrib:* Chinwari - Dudhganga.

## Novelties

During the present expedition following taxanomically very interesting plants were noticed which on critical study may prove to be new to the science.

*1. Saxifraga sp.*

I have seen two tufted Saxnfraga species, one on way to Patalkhan (4070 m). This plant is very much allied to S. *jacquimontiana* but differs in 2-3 characters. Another species seen around Dibrugheta-Deodi area which is allied to *S. oppositifolia.*

*2. Gentiana sp.*

One *Gentiana sp.* with yellow flowers is seen near Parkurdhar. This plant can also prove to be new on critical study.

Besides flowering plants, an interesting element in the flora of Nandadevi Bioshpere Reserve core zone are wood-rotting Aphyllo-phorales constituting a cosmopolitan group and fruiting mostly on dead woods/living trees. These fungi fruit, after rainy season (August-September), but following are some wood-roots collected during our expedition. Most of the collections have been found on *Betula utilis* at higher altitudes.

## Wood-rooting fungi

### *A. Cprtocoaceae*

1. *Hypholoma pallidium:* resupinate, pinkish to yellowish white; hyphae monomitic, spores 7-9 x 2-3.5 um; on dead rotting stumps of *Betula utilis;* RAMNI (3500 m), also grows on coniferous stumps.

2. *Lexitextum bicolor* (Pers.:Fr.) Lentz.

Effused-reflexed to pileate, spongy, brittle and fragile on drying; hyphae monomitic; Gloeocystidia present; spores 4-5 x 2.5-3 um, finely echinulate; on dead stumps of *Abies spectabilis;* RAMANI (3500 M).

### *B. Hymenochaetaceae*

*Vararia pallescens* (Schw.) Rog. & Jacks.

Resupinate, adnate, widely effused, up to 2 mm thick, light to dark brown; hyphae dimitic; dichohypiydia present; Gloecystidia rare; spores 6-7 um in diameter; on rotting logs of *Abies spectabilis;* on way to Ramni.

*Inonotus tenuicarnis* Pegler & Reid.

Annual, ferruginous to dark umbrinous, glabrous, scrupose; hyphae monomitic, setae absent; spores 5-6 um; caespitose at the baeofoaks; Ramni.

*Phellinus populicola* Niemla

Perennial, woody hard, greyish brown to black, margin rounded; pores 4-6- per mm, context umber brown, hyphae dimitic; setae misshapen, 10-18 x 4-6 um; spores hyaline, thick walled, 5-6 x 4-5 um; on *Sorbus acuparia;* Dudhganga

*P. ferreus* (Pers.) Bourd. & Galz.

Perennial, resupinate, yellowish to orange brown, pores 4-5 per mm; setae 25-40 x 6-10 um; spores 6-7.5 x 2-2.5 um; common on dead branches of *Sorbus acuparia;* Ramni.

*P. lundelli* Niemla

Perennial, resupinate to reflexe, crust distinct, reddish brown to black, pores 5-6 per mm, context deep fulvous, hyphaedimitic, setae abundant, 17-25 x 4-6 um, spores 4-6 x 4-5 um; on living/dead *Betula utilis;* Dudhganga.

*P. nigricans* (Fr.) Karst.

Perennial, pileate, applanate, glabrous, concentrically sulcate, black, crusty, pores 5-6 per mm, context rusty brown; hyphae dimitc, setae 12-16 x 4-6 um; spores globose, 6-7 x 6 um, on dead logs of *Betula utilis,* near Dhood Ganga.

*P. laevigatus* (Fr.) Bourd. & Galz.

Perennial, resupinate, pore surface greyish brown, shining, pores 6-8 per mm; setae 10-16 x 4-5 um; spores 5-6.5 x 4-5 um, very common and widely effused on *Betula utilis;* Dudhganga.

*C. Polyporaceae*

*Piptoporus betulina* (Fr.) Karst.

Annual, pileate, up to 20 cm wide and broad; contracted base; pileus glabrous, smooth, azonate, cuticle papery thin; pore surface pure white; context corky and homogeneous; hyphae dimitic; sporesallantoid; 5-6 x 1-2 um; exclusively on *Betula;* Dudhganga.

*Pycnoporus sanguineus* (Fr.) Murr.

Annual, solitary or in small groups, pileus orange red to orange cinnabar; margin narrow, context pink orange, floccose; pre surface pink orange, pores 3-4 per mm; hyphae dimitic; spores 4-4.5 x 2-2.3 um; common on dead logs; Dudhganga.

*Trichaptum abietinus* (Fr.) Ryv.

Annual, effused to pileate; surface dirty white, tomentose to velutinate, concentrically zonate; context whitish; pore surface decurrent, light violet to brownish, pores 2-3 per mm; hyphae dimitic; spores 5-8 x 23 um; comon on dead wood; Ramni.

*Trametes gibbosa* (Pers. Fr.) Fr.

Annual, sessile, single or imbricate; pilear surface white; context white; pore surface whitish, pore radially elongated, 2-3 per mm; hyphae trimitc; spores 4-5x 2-2.5 um; Ramni.

*T. tephroleuca* Berk.

Annual, sessile; pilear surface white, zoned, coarsely hirsute; margin thin; context white, floccose; pore surface greyish to yellowish white, pores 1-2 per mm; hyphae trimitic; spores 6-7 x 2-3 um; common on logs of hard woods; Ramni.

*Daedaleopsis confragosa* (Bolt. : Fr.) Schroet.

Annual, reniform, corky, imbricate; pilear surface maroon or yellow brown with dark bonds, concentrically zoned; margin narrow, hymenophore lamellate; lamellae 14-16 per cm; hyphae trimitic; spores 14-16 x 4-4.5 um; common on dead angiospermic woods; Ramni.

*Oxyporus populinus* (Fr.) Donk.

Annual to parennial, solitary to imbricate, pilear surface white, covered with mosses; margin narrow; context white; pore surface white; hyphae monomitic, septate; cystidia numerous and coarsely encrusted; spores 3-4.5 x 3-4 um; a rare species on rotten woods; Ramni.

*Heterobasidion insulare* (Murr.) Ryv.

Annual, pileate, imbricate; pilear surface reddish brown to blackish, margin narrow; context white, pore surface yellowish white, pors 4-5 per mm; hyphae dimitic; spores 4-5 um in diameter; common species on both living/ dead conifers; Deodi.

*Fomitopsis rosea* (Fr.) Karst.

Perennial, pileate, ungulate, blackish crust at the base, cracked irregularly; context pinkish brown; pore surface pinkish brown; pores 4-5 per mm; hyphae trimitic; spores 6-7 x 2-3 um; A common species on the coniferous logs; near Dudhganga.

*Conclusion :-*

The core zone of Biosphere Reserve is very rich in medicinal plants. It would be advisable to have a conservatory for *ex situ* conservation of these important economic plants outside the Biosphere Reserve area. This will also help in providing livelihood for the local inhabitants. For this purpose the Martoli-bugyal area in buffer zone of the Reserve and Auli above Joshimat, are recommended sites.

Since the Nanda Devi Biosphere Reserve has been closed for Mountaineering and other biotic activities only recently, any effect on the flora and fauna has not yet fully manifested. It is, therefore, proposed that atleast every third year some scientific monitoring should be carried out in Biosphere Reserve area for a realistic assessment of these aspects.

# WATER QUALITY TESTS

AJAY RASTOGI

WORLD WIDE FUND FOR NATURE INDIA

## INTRODUCTION

The boundaries of the Nanda Devi Biosphere Reserve is constituted by five rivers: Dhauli Ganga, Girthi Ganga, Gori Ganga, Pinder and Sunderdunga. The only river which originates from the heart of the core zone and runs through it before it meets the Dhauli Ganga is Rishi Ganga. Rishi Ganga flows in a deep gorge and covers a total length of approximately 20 kms.

It has a huge catchment comprising aspects of Dunagiri (7066m), Changabang (6864m), Kalanka (6934m), Rishi Pahar (6696m), Mangram (6586m), Nanda Devi (7817m), Nanda Devi East (7434m), Nanda Khat (6631m), Mrigthuni (6855m), Trisul I (7120m), Trisul II (6690m) and Bethartoli (6352m) mountains.

## OBJECTIVES

1. To establish baseline information on the quality of water in the Rishi Ganga river system.
2. To test the quality of drinking water sources in the buffer zone.
3. To test the quality of water at Badrinath, a pilgrim centre.

## METHODS

Standard titrimetric methods were used for Iron content and Dissolved Oxygen in the water samples. Microbiological tests were conducted to check the potability. Temperature and pH were also measured. The methodology was as per procedures outlined in the Field Manual for Water Quality Monitoring, WWF India, 1993.

There are four different sets of locations in which these tests were carried out. These were five points along the Rishi Ganga river, four different streams joining the Rishi Ganga, three points at Badrinath (carried out twice) - once at the beginning of the pilgrimage season and the other towards the middle (before the onset of the monsoon) and the drinking water sources of five villages in the buffer zone of the Nanda Devi Biosphere Reserve.

## RESULTS AND DISCUSSION

In the absence of any source of pollution, the water flowing in the river as well as the streams is absolutely pure. The only correlation of academic interest that can be inferred from the results is that between the altitude and the level of dissolved Oxygen. As could be expected the level of dissolved oxygen generally went down with decrease in atmospheric pressure. The atmospheric pressure decreases with the rise in altitude.

The drinking water quality in all the four villages surveyed is also completely satisfactory. In Dunagiri, water is taken directly from the stream coming from the glacier lying to the east of the village. In Tolma, Peng and Phagati the source of spring water is a bit distant for the village. Underground tanks made of cement and stone have been constructed right at the source.

The common taps, 1 to 2 in number in each of the villages, have been connected by galvanised iron pipes to these tanks. The longest pipeline is of about 3.5 kms in length coming from Phagati to Punwasa. Water samples for Tolma were taken directly from the spring as well as the village tap. No significant difference in water quality was observed and the same is true for the water samples in Phagati and Peng.

At Badrinath, the quality of water flowing in the Alaknanda river as well as that of the drinking water supplied by the local municipality was found to be devoid of any pollutant in measurable quantities on both the occasions.The only disappointment was the drastic drop in the level of dissolved oxygen (DO) in Tapt kund water. The temperature of water here was 39°C, and because of this the level of DO was 4.0 in normal conditions as recorded at the beginning of the season; while it became zero towards the middle of the season.

**Recommendation**

To decelerate the level of deterioration in the water quality of the Tapt kund following two measures may be suggested. Firstly soap should neither be allowed while bathing and nor should washing of clothes be permitted. Secondly, it would be better if people can have a bath in the taps connected with the same hot spring water source which feeds Tapt Kund before having a holy dip in Tapt kund itself.

## WATER QUALTY TEST ALONG THE RISHI GANGA RIVER SYTEM

| Location | Atitude (m) | Date | Time (Hrs.) | pH | Dissolved Oxygen mg/L | Hardness mg/L CaCO3 | Iron mg/L | Potability Test |
|---|---|---|---|---|---|---|---|---|
| Reni | 1990 | 6 May 93 | 0740 | 7 | 8 | 120 | Not Detected | Faecal Coliform Absent |
| Deodi | 3300 | 16 May 93 | 1320 | 7 | 6.5 | 200 | " | " |
| Debrughetta stream | 3440 | 13 May 93 | 0900 | 7.5 | 6.5 | 220 | " | " |
| Ramani | 3600 | 19 May 93 | 1720 | 7 | 7 | 380 | " | " |
| Trishul Nala | 3700 | 19 May 93 | 1130 | 7 | 7.5 | 320 | " | " |
| Sarson Patal | 4070 | 22 May 93 | 1600 | 7 | 7 | 180 | " | " |
| Base Camp | 5000 | 25 May 93 | 0830 | 7 | 6 | 180 | " | " |
| Sarson Patal Stream | 4170 | 22 May 93 | 1620 | 7 | 6 | 100 | " | " |
| Small lake at base camp | 5000 | 25 May 93 | 0830 | 7 | 5.5 | 140 | " | " |

## WATER QUALITY TESTS AT BADRINATH (3100m)

| Sampling Point | Date | Time (Hrs.) | pH | Hardness mg/L CaCO3 | Dissolved Oxygen mg/L | Iron mg/L | Potability Test |
|---|---|---|---|---|---|---|---|
| Tap Water | 6 May 93 | 1600 | 7 | 80 | 5 | Not detected | Faecal Coliform Absent |
| Alakanda River | 6 May 93 | 1545 | 7 | 40 | 5 | " | " |
| Tapt Kund | 6 May 93 | 1520 | 8 | 200 | 4 | " | " |
| Tap Water | 20 Jun 93 | 1230 | 7 | 90 | 5.5 | " | " |
| Alakanda River | 20 Jun 93 | 1210 | 7 | 50 | 7 | " | " |
| Tapt Kund | 20 Jun 93 | 1100 | 8 | 300 | 0.0 | " | " |

## DRINKING WATER QUALITY OF BUFFER ZONE VILLAGES

| Village | Atitude (m) | Date | Time (Hrs.) | pH | Dissolved Oxygen mg/L | Hardness mg/L CaCO3 | Iron mg/L | Potability Test |
|---|---|---|---|---|---|---|---|---|
| Tolma | 3000 | 5 Jun 93 | | | | | | |
| Tap | | | 1030 | 7.5 | 7.5 | 100 | Not Detected | Faecal Coliform Absent |
| Spring | | | 1100 | 7.5 | 7 | 80 | " | " |
| Phagati | 3500 | 8 Jun 93 | 1300 | 7 | 6 | 100 | " | " |
| Pangrasu | 2800 | 8 Jun 93 | 1200 | 7 | 5 | 80 | " | " |
| Dunagiri | 4000 | 11 Jun 93 | 1100 | 7 | 6 | 100 | " | " |
| Peng | 2750 | 16 Jun 93 | 730 | 7.5 | 6 | 120 | " | " |